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THE REPERTORY OF ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS,

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, &c.

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REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XIX.

I. *Specification of the Patent granted to The Earl of* DUNDONALD; *for his Method of preparing and obtaining Alum, or the Salt called Sulphat or Vitriol of Argil, and other Salts, Saline Matters, and Substances.*

Dated Oct. 4, 1794.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Archibald, Earl of Dundonald, in compliance with the said proviso, do hereby describe and ascertain the nature of my said invention, and declare that the alum, or the salt called sulphat or vitriol of argil, and the other salts, saline matters, and substances, are

 made

made as follows; that is to ſay, my firſt proceſs conſiſts of lixiviating, waſhing, or diſſolving, the ſaline matters contained in aluminous, vitriolic, or pyrituous rock ſchiſt, or ſubſtances, with ſea-water; or with ſolutions of ſea or rock ſalt, chemically called muriat of ſoda; or with ſolutions of kelp, ſandiver, ſoapers aſhes, ſalts, or leys; or with the ſolution of any ſaline ſubſtance containing muriat of ſoda. The ſea-water, or the ſolution of any of the above mentioned ſalts, may either be applied to lixiviate or diſſolve the ſaline matters contained in aluminous, vitriolic, or pyrituous ſchiſt, or materials, when theſe materials have been calcined by fire, or when they have been decompoſed by expoſure to air, as may beſt ſuit the nature of the materials. This proceſs may likewiſe be performed by mixing any ſaline ſubſtance containing ſea-ſalt or muriat of ſoda with aluminous, vitriolic, or pyrituous materials; and by afterwards diſſolving the ſaline matters, thus mixed together, by the addition of water. Or I perform this proceſs in another way, by adding ſea-ſalt or muriat of ſoda, or ſalts containing muriat of ſoda, or their ſolutions, to aluminous or vitriolic ſalts,

or

or to aluminous, or vitriolic, or pyrituous liquors, or solutions. It is proper here to mention, that, in the common process of alum-making, salts containing muriat of soda, or their solutions, are made use of, and mixed with the aluminous liquor, either in the process of boiling, or in the coolers or settlers. The salts used by the alum-makers are, kelp, soapers ashes or salts, and sandiver, or any alkaline salt to be had at a cheap rate. These alkaline salts are used for the purpose of neutralizing the superabundant proportion of vitriolic or sulphuric acid, contained in the aluminous liquor, and to promote thereby the crystallization of the alum, and with that view only; but, in my affidavit and petition, certain other salts, saline matters, and substances, are stated to be made, either in the process for alum-making, or in the processes connected therewith; therefore, whoever shall make use of sea-salt or muriat of soda, or salts, or their solutions, containing muriat of soda, and shall make, or cause to be made, sundry salts, saline matters, and substances, in the manner described in this specification, will be deemed to have infringed on this patent. These

ſalts, ſaline matters, and ſubſtances are, Glauber's ſalt, ſpirit of ſea-ſalt or muriatic acid, and ſal-ammoniac. Having ſtated the different methods of mixing ſea-ſalt or muriat of ſoda, or ſolutions of ſalts containing muriat of ſoda, with aluminous, vitriolic, or pyrituous ſaline matters, or materials, or with their ſolutions, I now proceed to deſcribe the other proceſſes. The liquor, reſulting from the mixtures before deſcribed, is to be boiled or prepared to the weight or concentration neceſſary for the cryſtallization of alum, and treated with or without alkaline ſalts, as ſhall be found neceſſary. The ſlam, mother-liquor, waſhings, or tun-liquor, as they are called at alum-works, proceeding from the laſt mentioned proceſs, or from any proceſs in the preparation of alum, are to be mixed with ſuch proportion of ſea-ſalt or muriat of ſoda, or ſalts, or their ſolutions, containing muriat of ſoda, as ſhall be requiſite. To this liquor or ſaline matter is to be added a due proportion of alum ſchiſt, clay, or argillaceous matter: the ſchiſt or clay which is found to anſwer beſt is what contains a large proportion of the earth of iron. The materials are then to be dried, ground

to

to a powder, and submitted to the action of heat, in a reverberatory, or other furnace, pot, or crucible, until the muriatic acid is expelled. For the more effectual expulsion of the muriatic acid, two different calcinations or applications of heat may be used, moistening the materials with water between the different calcinations: the materials are then to be lixiviated or washed with water. The lixivium, when the process has been properly conducted, will consist of a solution of Glauber's salt, which may either be chrystallized; boiled and evaporated to dryness; or kept in a liquid state; as the uses for these different preparations shall require. The residuum, after lixiviation, consists of an argillaceous ochrey matter; which, when there is much iron in the aluminous or vitriolic schist, or argillaceous matter used, or a large proportion of green vitriol or sulphat of iron, or muriat of iron, in the saline liquor, or materials, mixed with the before mentioned schist or clay, may, by washing, lixiviation, and drying, be rendered fit to be used as a pigment. The marine or muriatic acid, expelled by heat from the materials, as has been already mentioned, may,

 when

when it is thought proper to collect it, be collected by using the methods and vessels used by chemists: and sal-ammoniac may be formed, by combining muriatic acid, or muriatic acid gas, with volatile alkali, or volatile alkaline gas, procured from coal, tar, water, urine, soot, bones, or other materials. According to the above specification, I lay claim to the following inventions or discoveries, and the exclusive exercise of them during the patent: to lixiviating or washing aluminous, vitriolic, or pyrituous schist, or materials, with sea-water, or with solutions of salts containing muriat of soda; or to mixing salts containing sea-salt or muriat of soda, in any way, with aluminous, vitriolic, or pyrituous substances, for the purpose of making, as has been described, alum, Glauber's salt, muriatic acid, or sal-ammoniac; or to the mixing of sea-salt or muriat of soda, or any salt containing muriat of soda, or their solutions, with solutions of aluminous, vitriolic, or pyrituous materials, for the purpose of making Glauber's salt, muriatic acid, and sal-ammoniac. I likewise lay claim, under the patent, to the exclusive privilege of mixing sea-salt,

ſalt, or ſalts containing muriat of ſoda, or their ſolutions, with alum-ſlam, mother-liqour, waſh-ings of alum, or tun-liquor, for the purpoſe of making Glauber's ſalt, muriatic acid, and ſal-ammoniac. By the words aluminous, vitriolic, or pyrituous rock ſchiſt, or ſubſtances, is meant, and is to be underſtood, ſuch ſubſtances as, by calcination, or expoſure to air, or otherwiſe, con-tain, yield, or produce, alum or the vitriol or ſulphat of argil, green vitriol or the vitriol or ſulphat of iron, and Epſom ſalt or the vitriol or ſulphat of magneſia. Theſe ſalts are often found blended or mixed together, particularly in alum-ſchiſt, ſhale, or their ſolutions; at the ſame time, any one of theſe ſalts may be decompoſed ſingly, and by itſelf, and, by following the directions al-ready given, be made to produce, with muriat of ſoda, or ſalts containing muriat of ſoda, Glau-ber's ſalt or ſulphat of ſoda. For the manufac-ture of this article, the patent, of which this is the ſpecification, has been applied for, and taken out, included under thoſe words in the patent, " certain other ſalts, ſaline matters, and ſub-

ſtances;"

ſtances;" and accordingly, with the intervention or aid of argillaceous matter, or ferruginous argillaceous matter, Glauber's ſalt is produced by mixing ſulphat of alum, ſulphat of iron, or ſulphat of magneſia, (from whatever materials they are got or procured,) with muriat of ſoda, or ſalts containing muriat of ſoda, and then by applying to the materials a due degree of heat. It is proper likewiſe to mention, that I decompoſe muriat of ſoda, in a great meaſure, by ſulphat of magneſia, without the intervention or aid of argillaceous matter: this proceſs, diſcovered by me, I likewiſe reckon to be included in my patent. In witneſs whereof, &c.

II. *Specification of the Patent granted to Mr.* Edward Jones, *of the City of Briſtol, Sadler; for his Invention of a Woman's Saddle-tree, with a Spring-head, to prevent Danger from the Horſe's tripping, falling, &c.*

Dated May 27, 1794.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that, in compliance with the ſaid proviſo, I the ſaid Edward Jones do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, the near ſide head or horn, of a woman's ſaddle-tree, is made or conſtructed to move, fall, or drop down, by means of a ſpring or ſprings, catch or catches, or by any other method or means that can be adapted for that purpoſe, though I think a ſpring beſt; and may be made of ſteel, iron, or other metal, or

 com-

compofition of metal, or any other proper material, and faftened or fixed to the faddle, by one, two, or more fcrews, or any other proper faftening; fo that, when the rider wifhes to difmount, or difengage herfelf from the faddle, by pufhing or forcing the faid horn or head from her, it will inftantly fall or drop down, and the rider may with great eafe flip from the faddle, and her clothes will be prevented from entangling in the horn or head, which, upon a horfe tripping, falling, or running away, may be the means of preferving the rider's life; and will alfo be the means of freeing the rider, in mounting and difmounting, from many indelicacies which the conftruction of the prefent faddles fubjects her to. The fpring horn or head may be weakened or ftrengthened, as the ftrength of the rider may require, by turning one or more fcrew or fcrews, or other proper fubftitutes, which may be let into the wood, at the upper part of the near point, or fome other convenient part, by which the horn or head is prevented falling, or in the leaft moving, contrary to the pleafure of the rider; for, fhould the head or horn of a woman's faddle fall down with every

little

little motion of the rider, the danger would counterbalance the utility. The horn or head is made to fall, or drop down, at the collar-welt, or bottom of the head, not only on a parallel with the off ſide head, but ſo low as to reſt on the point of the tree; and, when made into a ſaddle, it reſts on the ſeat and ſkirt, near the tuffnail, and thereby precludes the leaſt entanglement whatever. As the horn or head of women's ſaddles has not ever before, in this kingdom, been conſtructed or made to fall or drop down, I therefore claim myſelf to be entitled to every poſſible mode, way, and method, by which ſuch horn or head can be made to fall or drop, as being the principle of my invention. In witneſs whereof, &c.

III. *Specification of the Patent granted to Mr.* Benjamin Wiseman, *Jun. of Diſs, in the County of Norfolk, Merchant; for his new-invented Sails for Windmills, with horizontal Levers.*

WITH TWO PLATES.

Dated Nov. 15, 1783.

To all to whom theſe preſents ſhall come, &c. Now know ye, that I the ſaid Benjamin Wiſeman, in purſuance of, and in compliance with, the ſaid proviſo, and the purport and true intent and meaning of the ſaid letters patent, and of his Majeſty's ſaid moſt gracious intention, do, by this inſtrument in writing, under my hand and ſeal duly executed, declare that my ſaid new-invented ſails for windmills, with horizontal levers, which work or move with the wind from any quarter, without wanting the help or aſſiſtance of any perſon, as formerly required by the

common

common windmills, are deſcribed in and by the drawings, ſections, and plans, hereunto annexed, with the references or indexes thereunto belonging, and hereunto alſo annexed. In witneſs whereof, &c.

DESCRIPTION OF THE NEW-INVENTED SAILS FOR WINDMILLS, WITH HORIZONTAL LEVERS, AND SUCH OTHER PARTS OF THE MACHINERY AS ARE CONNECED THEREWITH, AND NECESSARY THERETO.

Fig. 1 (Plate I.) repreſents a ſection of the mill, to ſhew the ſhaft or axle, the horizontal levers, and the maſts to which the ſails are applied. A B is the ſhaft, which ſhould be of good oak-timber, the length and thickneſs whereof may be increaſed, or diminiſhed, as beſt toſerve the end or purpoſe for which it is intended. C D are the horizontal levers, (of fir-timber,) which paſs through mortiſes cut in the head of the ſhaft A B, at right angles with each other, and making a right angle with the ſhaft. Theſe levers may be

be of any indefinite length and thickneſs, in proportion as they are required to produce a greater or leſs degree of force; when they exceed the length of ſeventeen or eighteen feet from the centre, it may be found neceſſary to add ſtocks, as EF, to ſtrengthen and ſupport them. At the ends of theſe levers four maſts are affixed, as at GH, which may be varied in ſize, according to the work they are to do. Here let it be remarked, that, as no perſons have ever thought of placing maſts and ſails at the end of horizontal levers, to act with a rotative force, the identity of this invention conſiſts therein, however the figure of the ſails may be varied; for ſails may be cut in a variety of forms, and be nearly equal to each other in effect. The ſails are drawn up and let down, from withinſide the mill, by the halyard *a a a a*, which paſſes over a ſheeve or pulley near the top of the maſt; changing its direction at *b*, it runs horizontally to the ſhaft, where its direction is again changed by another ſheeve *c*, and, paſſing through a hole in the ſhaft, it comes down on the inſide of the mill, and is hooked on a half-ſtaple at the foot of the ſhaft. To diſtinguiſh

the

the directions of this line, it is marked in the drawings red *. The ſails are drawn to a proper angle with the wind by four ſheet lines, which go from the corner of each ſail, and, paſſing through four holes in the ſhaft, come down parallel with it, withinſide the mill, and are faſtened to four hooks.

Fig. 2 is a plan of the levers, braces, ſtays, &c. A repreſents the head of the ſhaft. B B B B, the four levers. C C C C are four braces, to ſtrengthen and tye together the levers. D D D D are four fir-poles, which are called ſtays; their uſe is to keep the ſails to their proper angle, by means of four pulley-blocks *d d d d*, through which paſs the ſheet lines *e e e e* to the ſheeves *c c c c*, and thence, through four holes in the ſhaft, to the inſide of the mill. E E E E are the ſails. The maſts are affixed to their levers by four boxes, with ſcrew-bolts, and nuts.

One very great convenience reſulting from the poſition of theſe ſails is, the great celerity with which they may be ſtruck. It frequently occurs,

* In our figures it is repreſented by dotted lines.

from

from fudden gufts of wind, that the gripe of the common mill is not fufficient to overcome the exceffive force of the wind during a ftorm; and mills are frequently damaged, from not being able to take in their fails in fuch perilous weather: but it will be fhewn, by the following figures and defcription, that, in this conftruction, the fails may not only be let down in an inftant by the perfon who works the mill, but that, when the wind increafes, fo that the fails move with more than a given velocity, they fhall be ftruck of themfelves, without the attendance of any one. In mills for grinding of corn, it is neceffary to have a perfon prefent, to apply the ftones according to the increafe or decreafe of the wind, fo that this contrivance is not of much confequence to fuch mills; but, in thofe for drawing marfhes, or forcing water, a conftant attendance may be difpenfed with, when fuch a provifion is made againft the effects of fudden ftorms.

Fig. 3 (Pl. II.) exhibits a tranfverfe fection of the fhaft, to fhew the pofition of the half-ftaples 1 2 3 4. Each halyard has at its end an iron ringle, which is flipt into the half-ftaples. When the fails are hoift-

ed,

ed, the shaft, staples, and halyards, move together, in the direction marked by the dart; but, while they are moving round, if any impediment be suddenly obtruded into the position *c d*, just above the staples, each ringle, with its halyard, will be forced from off the staples as they pass this catch, and the sails will run down the masts, so that, in one revolution of the shaft, all force will be lost, and the mill will stop. The form of this catch is shewn at the bottom of Fig. 4. A line communicating with this catch may be carried to any part of the mill, and the sails may be let down whenever it is proper or necessary.

Fig. 4 shews the machine by which the sails are let down, when their velocity exceeds a certain rate. The principle of this machine is, that tendency which all bodies, moving in circles, have to fly off from the centres of motion, which is called the centrifugal force; the increase of which force is as the square of the velocity. A B is the shaft of a fen-mill; C D the arms of the cog-wheel, on one side of which this machine is fixed: it consists of the following parts. The pendulous ball 2, of brass or iron, movable upon its

centre 1, is connected, by a wire 3, with the bended lever 4 6, which moves upon its centre 5. Upon the arm 6, of this lever, is a regulating weight 7, with a ſcrew to ſet it faſt upon any part of the arm 6; now the nearer this weight approaches to the end 6, the greater is its power, being farther removed from the centre of motion 5, and of courſe the greater its action upon the ball 2. If this weight is fixed at ſuch part of the arm 6, that its action upon the ball 2 ſhall be juſt ſufficient to keep it from flying off when the ſails rotate twenty times in a minute, upon the velocity of the ſails being increaſed by a ſtorm, the ball will acquire ſuch force as will over-balance the weight 7, and draw forward the end of the lever 4, ſo as to make it touch the trigger *a*, let down the catch *d*, and releaſe the ſails.

Fig. 5 is a ſide-view of the trigger; *a b* are the two arms of the trigger, movable upon a centre pin; *c* is a latch movable upon a pin. Whilſt the long arm of the trigger *a* is perpendicular, the latch *c* ſupports the weight of the catch *d*; but, when *a* moves in the direction of the dart, by

 the

the impulse of the lever 4, (see the last figure,) *b* rises up, and, leaving *c* unsupported, the catch *d* falls, and sweeps the halyards from their staples. The line *e* prevents the catch-line and ringle from falling to the ground.

The vertical position of the shaft, and the convenient form which the building may have, (from not being obliged to be set to the wind,) give an advantage of some consequence to these new-constructed sails; for, when there is but just wind enough to swell the sails, a horse may be applied to the shaft, with great advantage; the upper stories of the building may serve for store-rooms, and the works of the mill; and the ground-floor may be employed as a horse-walk; but, to prevent any accident from happening to the horse by a sudden gale of wind, which would throw him upon his face, the following provision is made.

In the lower part of Fig. 1. 1 is the beam by which the horse draws, which is supported by a cast iron brace 2. The lower part of the shaft is round; the end of the beam 3, and the horizontal part of the brace 4, receive the shaft as a

ſocket, and are freely movable upon the ſhaft. The beam is kept at its proper height by two boſſes, 5 and 6. Juſt below the beam, a ratchet-wheel 7 is fixed to the ſhaft. Upon the beam, at 8, is fixed an iron click, which takes into the teeth of the ratchet-wheel. Now it is eaſy to underſtand, that when the beam is forced forward by the horſe, the click will preſs againſt the ratchet-teeth of the wheel, and the horſe and ſhaft will move together; but when, by an increaſe of the wind, the velocity of the ſhaft exceeds that of the horſe, the click will then be looſe, and the horſe will have no force upon him.

Fig. 6 is a perſpective drawing of the mill.

Fig. 1

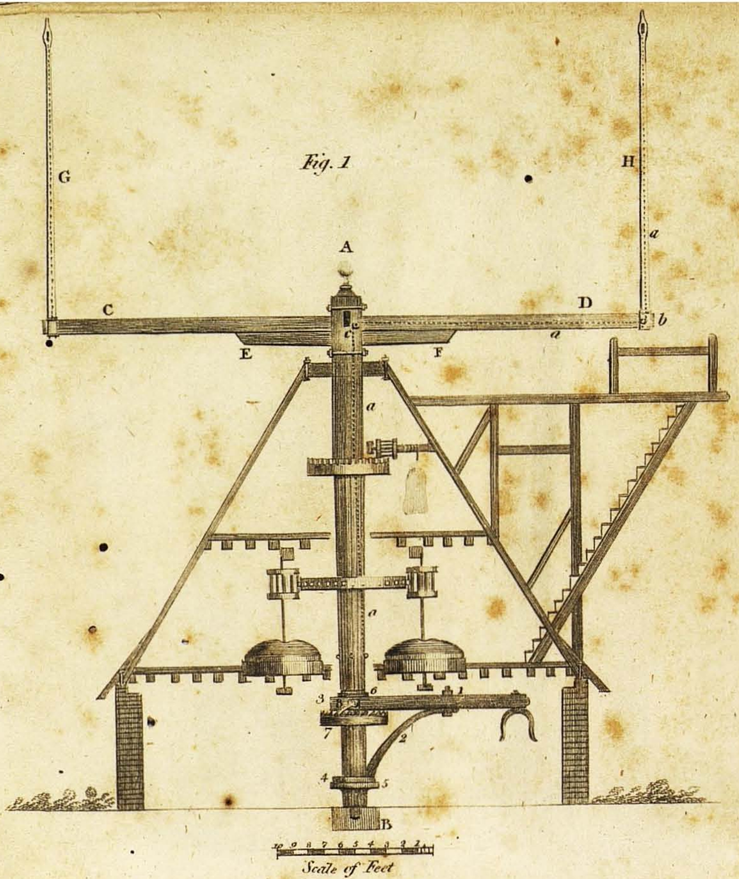

A
G
H
C
D
E
F
a
b
c
B
1
2
3
4
5
6
7
10 9 8 7 6 5 4 3 2 1
Scale of Feet

Fig. 2

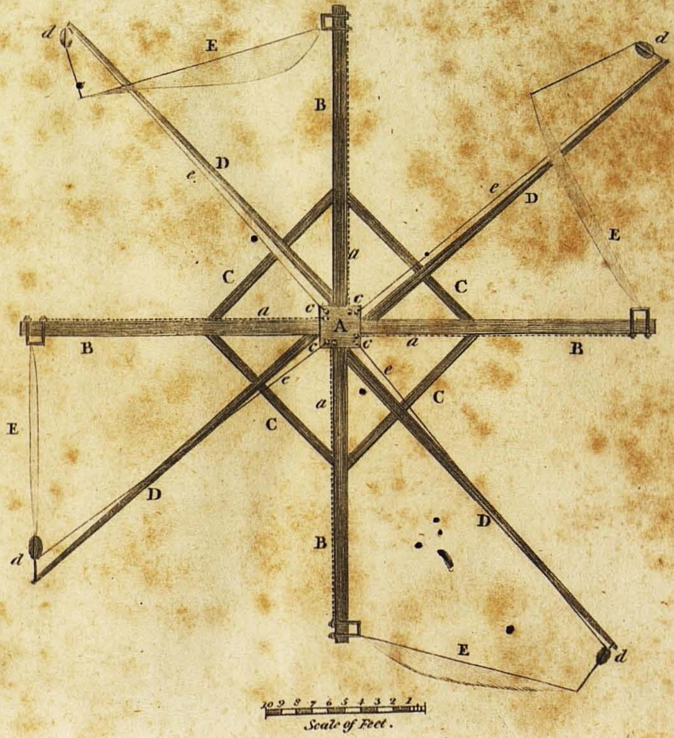
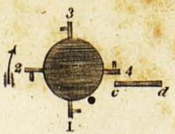

A
B
C
D
E
a
c
d
e
10 9 8 7 6 5 4 3 2 1
Scale of Feet.

Fig. 3



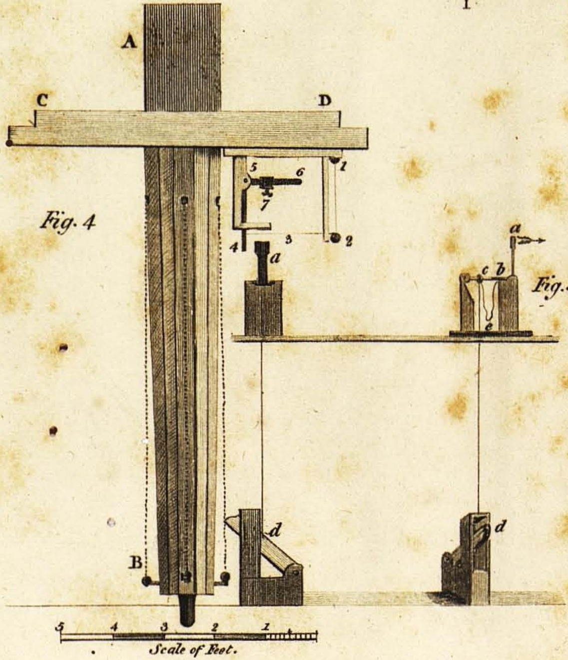


Fig. 4

Fig. 5

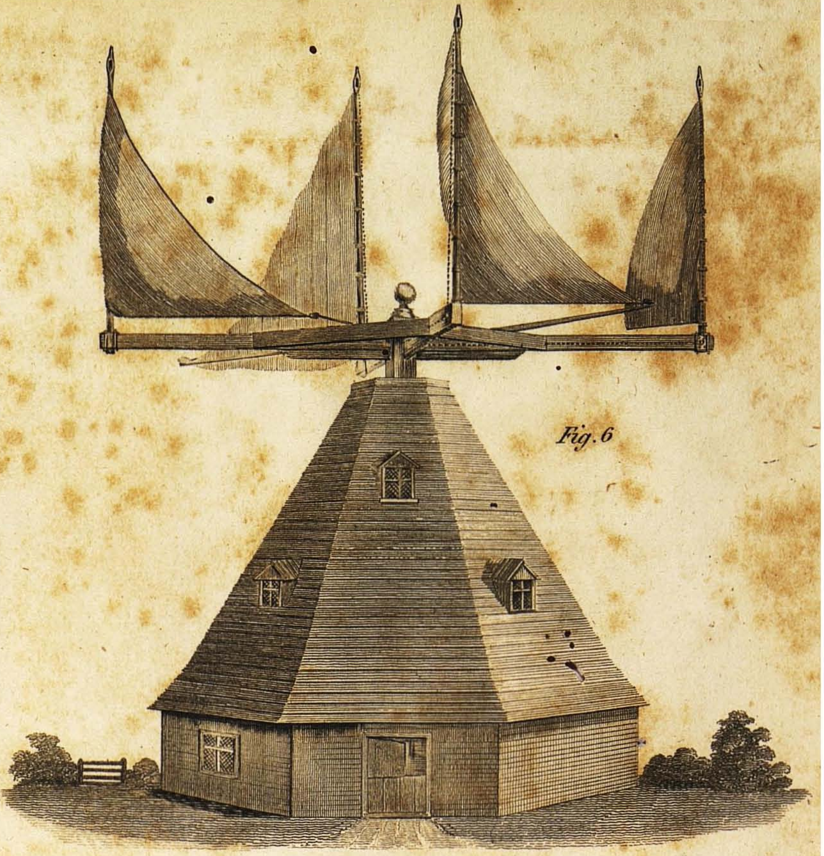


Fig. 6

IV. *Specification of the Patent granted to Mr.* John Kent Tarrant, *of King-Street, Bloomſbury-Square, Painter; for his Invention of painting, ſpangling, gilding, and ſilvering, Glaſs, and thereby ornamenting Carriages, &c.*

Dated Feb. 28, 1778.—Term expired.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that, in compliance with the ſaid proviſo, I the ſaid John Kent Tarrant do hereby declare, that my ſaid invention of painting, ſpangling, gilding, and ſilvering, glaſs, thereby ornamenting carriages, ſedan-chairs, buildings, furniture, muſical-inſtruments, or any other matters, where ornamenting ſhall be thought neceſſary, intirely new, and not before practiſed by any perſon whatſoever, is of the nature, and performed in the manner, following; that is to ſay, the painting muſt be performed on the back of the chryſtal, or glaſs, ſo as when finiſhed to appear

pear on the front: the colours prepared in oil, or varnifh, as in other work. The parts of ornament which are gold muft be firft fhadowed on the glafs, and when quite dry the gold-leaf muft be laid on: filver ornament muft be done in the fame manner. For the fpangling, leave the parts to be fpangled till the laft, then fhadow them, and when dry varnifh the parts with glutinous copal varnifh, and ftrew the fpangles on while it is wet; when the fpangles are quite dry, varnifh them two or three times. If the fpangling is to be white, ufe filver fpangles. If yellow, ufe gold fpangles. If blue, glaze the parts to be fpangled with fine Pruffian blue, ground very fine in oil, or varnifh, and lay on filver fpangles. If green, glaze the parts with tranfparent green. If crimfon, ufe the beft fine lake. If purple, ufe a mixture of Pruffian blue and fine lake. To make the painting appear more raifed, paint the ornaments, and leave the ground of the chryftal, or glafs, quite clear, and put another plate of glafs coloured behind (about an inch or more, according to the fize) the glafs painted on. In witnefs whereof, &c.

V.

V. *Deſcription of a Tumbrel, for giving Food to Sheep in Winter. In a Letter to the Editors.*

WITH A PLATE.

GENTLEMEN,

IN an excurſion I made a few weeks ago to the ſea-coaſt of Lincolnſhire, I met with an ingenious, though very ſimple, invention of a tumbrel, (as it is there called,) for giving food to ſheep in winter-time. Having reaſon to believe the uſe of it is not yet extended much beyond the village where I ſaw it, I thought a deſcription of it might not be unworthy of a place in your publication. Whether it falls within the plan of the Repertory of Arts to admit of matters apparently ſo artleſs, I know not: this I know, if being perfectly adequate to the purpoſe it is intended for, and *at the leaſt poſſible expence*, gives merit to an invention, what I now ſend you will not, I flatter myſelf, be deemed ſo trivial a contrivance as, at firſt ſight, it may appear. It is,

is, in ſhort, nothing more than a wattled crib, in the form of a circular cage, made of willow, or any other flexible bruſh-wood. (See Plate III. Fig. 1.) It is ten feet in circumference, cloſe wattled one foot high, then left open for about fifteen inches, and then cloſe wattled again about eight or nine inches higher; an aperture being left at the top, about eighteen inches over, to put in the provender. The ſtaves, which form the ſkeleton of the work, are ten inches aſunder, ſo that each tumbrel admits of twelve ſheep to feed at a time. The obvious advantages of this invention are: 1. It preſerves the food from being trampled or dunged upon. 2. It prevents the ſtronger ſheep from puſhing away the weaker ones; each being confined, while feeding, by the head. 3. Its lightneſs, ſo that it may be daily ſhifted with very little trouble. 4. Its cheapneſs, the price being only two ſhillings a piece; with care they will laſt, as my informer told me, eight or ten years. The ſketch I ſend you (imperfect as it is) will explain the thing at once. I am, &c.

E. C.

VI.

VI. *Deſcription of a Wheel-drag, for preventing Accidents which frequently happen to Horſes drawing loaded Carts down ſteep Hills; by Mr.* JOSEPH KNEEBONE, *of Marazion, in Cornwall.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Twenty Guineas was given to Mr. KNEEBONE for this Invention; the Deſcription of which is preceded by Two Letters from Mr. MOYLE, of Marazion.

IN his firſt letter, Mr. Moyle ſays, that this drag is a ſafe and effectual method of ſtopping carts, or other two-wheeled Carriages, in deſcending ſteep hills, ſo as to take off the great burden from the back of the ſhaft-horſe, and to permit the carriage to deſcend with the greateſt eaſe and ſafety,

even in the moſt mountainous country, and that within theſe ſix months its uſe has become general, particularly among farmers; alſo that it may be applied to any kind of roads, not being ſubject to the inconvenience of locking-poles, which, in rough roads, or deep ruts, are very apt to overturn carts, by the ſudden reſiſtance they meet with.

Of Mr. Moyle's ſecond letter (which is in anſwer to one from the ſociety, deſiring he would procure for them a drag of a proper ſize) the following is an extract.

The ſmith informs me, that enlarging the wheel, or increaſing the length of the ſhoulders, gives the drag great advantages, by making it leſs liable to be choaked with mud, and by giving it a facility to adapt itſelf to hills of little or conſiderable ſteepneſs, which it does readily, by placing itſelf leſs or more forward. It does not appear that any great weight is applied to the wheel; and, for that reaſon, wheels made of caſt-iron, with ſpokes, will anſwer equally well, are lighter, and leſs expenſive.

By

By frequent uſe, the part on which the greateſt preſſure is applied will be worn away, ſo as to injure the machine; but, in order to prevent that, it is neceſſary to ſhoe it, at its firſt onſet, by fixing on a plate of iron, (ſteel I ſhould imagine better,) by means of two holes in its bottom, which will always receive a ſimilar piece, when it may be wanted, ſo that the drag is eaſily kept in good repair.

Theſe letters are followed by a certificate, ſigned by three farmers and carters, who certify that they have lately made uſe of this wheel-drag, by applying it to their carts; that it is ſimple and eaſily applied; and that it effectually ſtops two-wheeled carriages in deſcending ſteep hills; taking off the additional weight thrown on the back of the ſhaft-horſe, ſo as to enable them to convey as much weight down the ſteepeſt hill as on a level, and with as much eaſe to the ſhaft-horſe.

They apply the wheel-drag, on the brow of the hill, to the near-wheel, faſtening it to the ſhaft by a chain, to prevent the wheel from paſſing over it, in caſe of great obſtacles;

and they have never obſerved that deep ruts, or looſe ſtones, in any manner leſſen the advantages which this contrivance is calculated for. Inſtead of a loaded cart running on the heels of the ſhaft-horſe on deſcending hills, this drag, by ſupporting and elevating the wheel, places it on a level, ſo as to oblige the horſe to draw a ſmall burden; and, in ſome inſtances, it is even neceſſary to link the chain-horſe to the dragged-wheel ſide, by which means a weak horſe may be placed within the ſhafts without any danger. After the cart is deſcended to the bottom of the hill, the drag is taken off, and hung under the cart.

Explanation of the Figure.

(See Plate III. Fig. 2.)

a a a. A piece of wrought-iron, curved to the exact form of a cart-wheel, with the thickeſt part at *b*, on which the weight of the cart reſts.

1 2 3 4 are ſhoulders, which keep the wheel within the drag, and ſhould be about four inches high.

c. The

Fig. 1.

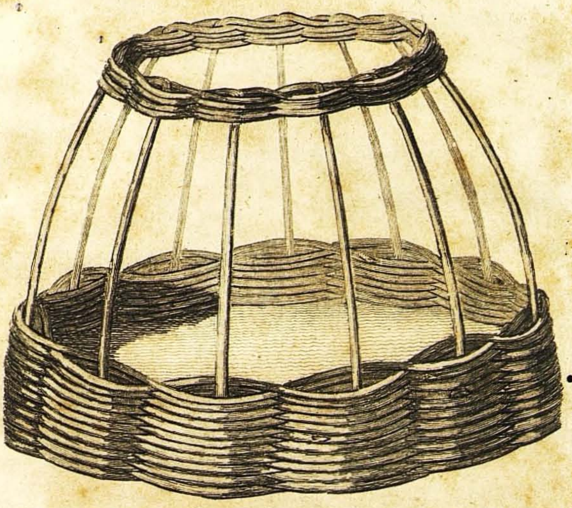
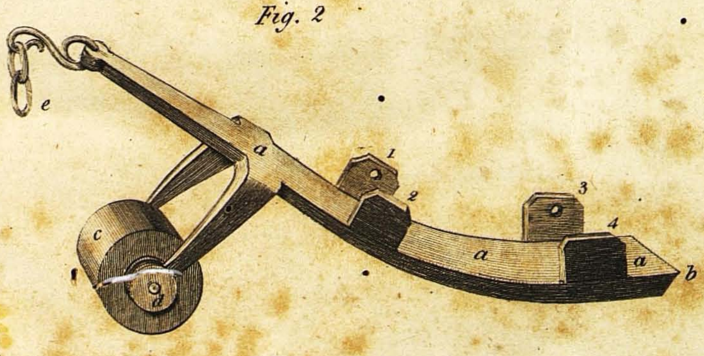


Fig. 2



c. The wheel, made of ſolid iron, nearly as wide as the drag, and ſeven inches in diameter; it runs on its axis at *d*, has a ſtrong ſhoulder, and, ſtanding forward, reſiſts the ſudden jolts of rough roads.

e. The chain to be faſtened to the near-ſhaft, to keep the drag properly under the wheel, which from jerks might be apt to paſs over the drag, and leave it behind: this is a proper precaution, though ſeldom wanted if the drag is well conſtructed.

In the ſhoulders 1 and 3 are ſhewn holes, by which the drag is hung on hooks, at the under part of the tail of the cart, when out of uſe.

VII. *Experiments upon Heat; by Major-General Sir* Benjamin Thompson, *Knt. F. R. S.*

From the Transactions of the Royal Society of London.

Since my laſt communication upon the ſubject of heat, which the Royal Society have done me the honour to publiſh in their Tranſactions, I have made ſome farther progreſs in the inveſtigation of that moſt intereſting ſubject, of which I propoſe now to give an account.

The confining and directing of heat are objects of ſuch vaſt importance in the œconomy of human life, that I have been induced to confine my reſearches chiefly to thoſe points, conceiving that very great advantages to mankind could not fail to be derived from the diſcovery of any new facts relative to theſe operations.

If the laws of the communication of heat from one body to another were known, meaſures might

be taken with certainty, in all cafes, for confining it, and directing its operations; and this would not only be productive of great œconomy in the articles of fuel and clothing, but would likewife greatly increafe the comforts and conveniences of life, objects of which the philofopher fhould never lofe fight.

The route which I have followed, in this enquiry, is that which I thought bid faireft to lead to ufeful difcoveries; without embarraffing myfelf with any particular theory, I have formed to myfelf a plan of experimental inveftigation, which I conceived would conduct me to the knowledge of certain facts, of which we are now ignorant, or very imperfectly informed, and with which it is of confequence that we fhould be made acquainted.

The firft great object which I had in view, in this enquiry, was to afcertain, if poffible, the caufe of the warmth of certain bodies, or the circumftances upon which their power of confining heat depends: this, in other words, is no other than to determine the caufe of the conducting, and non-conducting, power of bodies.

To

To this end, I began, by determining, by actual experiment, the relative conducting powers of various bodies of very different natures, both fluids and solids; of some of which experiments I have already given an account in the paper above mentioned, which is published in the Transactions of the Royal Society, for the year 1786 *; I shall now, taking up the matter where I left it, give the continuation of the history of my researches.

Having discovered that the Torricellian vacuum is a much worse conductor of heat than common air, and having ascertained the relative conduct-

* The paper here referred to consists of experiments to determine the conducting power of mercury, water, air in different states of density, and the Torricellian vacuum. From the results of those experiments it appears, that the power of those mediums to conduct heat, taking mercury as equal to 1000, is as follows, viz.

Mercury - - -	1000
Water - - -	342
Moist air - - -	330
Common air, density = 1 -	$80\frac{41}{100}$
Rarefied air, density = $\frac{1}{4}$ -	$80\frac{23}{100}$
Rarefied air, density = $\frac{1}{24}$ -	78
The Torricellian vacuum -	55

ing

ing powers of mercury, of water, and of air, under different circumſtances, I proceeded to examine the conducting powers of various ſolid bodies, and particularly of ſuch ſubſtances as are commonly made uſe of for clothing.

The method of making theſe experiments was as follows: a mercurial thermometer, whoſe bulb was about $\frac{55}{100}$ of an inch in diameter, and its tube about ten inches in length, was ſuſpended in the axis of a cylindrical glaſs tube about $\frac{3}{4}$ of an inch in diameter, ending with a globe 1 inch $\frac{6}{10}$ in diameter, in ſuch a manner that the centre of the bulb of the thermometer occupied the centre of the globe; and the ſpace between the internal ſurface of the globe, and the ſurface of the bulb of the thermometer, being filled with the ſubſtance whoſe conducting power was to be determined, the inſtrument was heated in boiling water, and afterwards, being plunged into a freezing mixture of pounded ice and water, the times of cooling were obſerved, and noted down.

The tube of the thermometer was divided at every tenth degree from o°, or the point of free-

zing*, to 80°, that of boiling water, and these divisions being marked upon the tube with the point of a diamond, and the cylindrical tube being left empty, the height of the mercury, in the tube of the thermometer, was seen through it.

The thermometer was confined in its place by means of a stopple of cork, about 1½ inch long, fitted to the mouth of the cylindrical tube; through the centre of which the end of the tube of the thermometer passed, and in which it was cemented.

The operation, of introducing into the globe the substances whose conducting powers are to be determined, is performed in the following manner: the thermometer being taken out of the cylindrical tube, about two-thirds of the substance which is to be the subject of the experiment are introduced into the globe; after which, the bulb of the thermometer is introduced a few inches into the cylinder, and after it the remainder of the substance, being placed round about the tube of the thermometer; lastly, the thermometer being introduced farther into the tube, and

* It may not be improper to observe that Reaumur's scale is used throughout this paper.

being

being brought into its proper place, that part of the ſubſtance which, being introduced laſt, remains in the cylindrical tube above the bulb of the thermometer, is puſhed down into the globe, and placed equally round the bulb of the thermometer, by means of a braſs wire, which is paſſed through holes, made for that purpoſe, in the ſtopple cloſing the end of the cylindrical tube.

As this inſtrument is calculated merely for meaſuring the paſſage of heat in the ſubſtance whoſe conducting power is examined, I ſhall give it the name of *paſſage-thermometer*; and I ſhall apply the ſame appellation to all other inſtruments conſtructed upon the ſame principles, and for the ſame uſe, which I may in future have occaſion to mention; and, as this inſtrument has been ſo particularly deſcribed, both here and in my former paper upon the ſubject of heat, in ſpeaking of any others of the ſame kind in future it will not be neceſſary to enter into ſuch minute details. I ſhall, therefore, only mention their *ſizes*, or the diameters of their bulbs, the diameters of their globes, the diameters of their cylinders, and the lengths and diviſions of their tubes; ta-

king it for granted that this will be quite ſuffi-cient to give a clear idea of the inſtrument.

In moſt of my former experiments, in order to aſcertain the conducting power of any body, the body being introduced into the globe of the paſſage-thermometer, the inſtrument was cooled to the temperature of freezing-water; after which, being taken out of the ice-water, it was plunged ſuddenly into boiling water, and the times of heating, from ten to ten degrees, were obſerved and noted, and I ſaid that theſe times were as the conducting power of the body inverſely; but, in the experiments of which I am now about to give an account, I have in general reverſed the operation; that is to ſay, inſtead of obſerving the times of heating, I have firſt heated the body in boiling water, and then, plunging it into a mixture of pounded ice and ice-cold water, I have noted the times taken up in cooling.

I have preferred this laſt method to the former, not only on account of the greater eaſe and convenience with which a thermometer, plunged into a mixture of water and ice, may be obſerved, than when placed in a veſſel of boiling water, and ſurrounded

rounded by hot steam, but also on account of the greater accuracy of the experiment; the heat of boiling water varying with the variations of the pressure of the atmosphere; consequently the experiments made upon different days will have different results, and of course, strictly speaking, cannot be compared together; but the temperature of pounded ice and water is ever the same, and of course the results of the experiments are uniform.

In heating the thermometer, I did not in general bring it to the temperature of the boiling water, as this temperature, as I have just observed, is variable; but, when the mercury had attained the 75° of its scale, I immediately took it out of the boiling water, and plunged it into the ice and water; or, which I take to be still more accurate, suffering the mercury to rise a degree or two above 75°, and then taking it out of the boiling water, I held it over the vessel containing the pounded ice and water, ready to plunge it into that mixture the moment the mercury, descending, passed the 75th degree.

TO BE CONTINUED IN OUR NEXT.

VIII.

VIII. *Description of a new-invented Instrument for Navigation, by which every Case in plane, middle Latitude, or Mercator's sailing, may be performed without Logarithms, Tables, or any numerical Calculations whatsoever;* by JOHN COOKE, *Esq. M. R. I. A.*

WITH A PLATE.

From the TRANSACTIONS of the ROYAL IRISH ACADEMY.

THE object of this instrument is, to facilitate the art of navigation, by resolving mechanically every problem necessary in sailing.

It is composed of a base, a perpendicular, a semi-circle, and an index; which are so connected by slides, as to be capable of being moved into every necessary position. The semi-circle contains the degrees of the circle, and also the points of the compass, for the purpose of laying off the course; the index, perpendicular, and outside edge of the base, represent the distance, depar-

 ture,

ture, and proper latitude, reſpectively; they are equally graduated, and each diviſion ſtands for a mile. There is alſo another line on the baſe, repreſenting the meridional parts; it is engraved on a cylinder, contained within a groove in the baſe, and any part of this line neceſſary may be eaſily had, by revolving the cylinder until it appears through the aperture prepared for that purpoſe.

The method of working every caſe which occurs in navigation is, to make the inſtrument ſimilar to that ideal triangle which is compoſed of the difference of latitude, departure, and diſtance ſailed; or to that compoſed of the meridional difference of latitude, difference of longitude, and enlarged diſtance; or to that compoſed of the difference of longitude, departure, and ſine of the middle latitude, which is done by means of the data procured from the compaſs, log-line, and quadrant: whence it follows, from the nature of ſimilar triangles, or from the relation which exiſts between the ſides of a triangle, and the ſines of their oppoſite angles, that the parts of the inſtrument become proportional to theſe which they repreſent, and will aſcertain the length of the

the lines, or the extent of the angles sought, by its graduations.

To make this general rule more easily understood, it is here particularly applied to each of the cases of navigation.

CASE I.

The latitudes and longitudes, of two places, given, to find the direct course, and distance between them.

Required the course and distance between
Lat. 50° 50′ N. Long. 19° 00′ W. and
Lat. 54° 30′ N. Long. 15° 30′ W.

The rule, on the principles of *Mercator's sailing*, is,

Move the centre of the semi-circle perpendicularly over the meridional degree corresponding with the latitude departed from, 50° 50′ N. (by means of a square,) then move the box until the edge of the perpendicular cuts the meridional parts of the latitude in 54° 30′ N. and move the index

index until it cuts the difference of longitude, 3° 30′, on the perpendicular, and the index will mark the courſe, 30° 10′, or N.N.E. $\frac{3}{4}$ E. nearly, on the ſemi-circle.

To find the diſtance ſailed, ſcrew the index to this courſe, and move the centre of the ſemi-circle to the proper latitude ſailed from, 50° 50′ N. and the edge of the perpendicular to the proper latitude arrived at, 54° 30′ N. and then the perpendicular will cut the diſtance, 254 $\frac{7}{10}$ miles, on the index.

On the principles of *middle latitude ſailing*, it is performed thus:

Half the ſum of both latitudes taken from 90°, leaves the complement of the middle latitude 37° 20′; and the leſs longitude, ſubtracted from the greater, leaves the difference of longitude 3° 30′, or 210 miles.

Move the centre of the ſemi-circle to the proper latitude departed from, 50° 50′ N. and the edge of the index to the complement of the middle latitude, 37° 20′, on the ſemi-circle; then move the box until the edge of the perpendicular interſects the termination of the difference of longitude, 210

 miles,

miles, on the index, which point of intersection will mark the departure, 128 miles, on the perpendicular; then move the edge of the perpendicular to the proper latitude arrived at, 54° 30′, and the index until it cuts the departure, 128 miles, on the perpendicular; then will the perpendicular mark the distance on the index, 254$\frac{7}{10}$ miles, and the index will mark the course on the semi-circle 30° 10′, or N.N.E. ¾ E. nearly.

CASE II.

Both latitudes, and course, given, to find the distance, and difference of longitude.

Lat. 50° 50′ N. Long. 19° 00′ W. sailed from.
Lat. 54° 30′ N. arrived at. Course N. 30° 10′ E.

By Mercator's sailing.

Move the box and semi-circle, as in the former case, to the meridional parts of the given latitudes, then set the index to the course, and it will mark the difference of longitude, 3° 30′, on the perpendicular 15° 30′ W.

Then,

Then, to find the distance, move the perpendicular and semi-circle to the proper latitudes given, and the perpendicular will cut the distance, $254\frac{7}{10}$ miles, on the index.

By middle Latitude sailing.

Complement of the middle Lat. $37^{\circ}\ 20'$.

Move the semi-circle and perpendicular to the latitudes given, and the index to the course; then the perpendicular will shew the departure, 128 miles, and the index the distance, $254\frac{7}{10}$ miles, at the point of intersection.

To find the difference of longitude, set the index to the complement of the middle latitude on the semi-circle, and move the box until the termination of the departure, on the perpendicular, meets the index, which will mark the difference of longitude thereon 210 miles, or $3^{\circ}\ 30'$.

CASE III.

Both latitudes, and distance, given, to find the course, and difference of longitude.

Lat. 50° 50′ N. Long. 19° 00′ W. sailed from.
Lat. 54° 30′ N. arrived at. Distance sailed $254\frac{7}{10}$ miles.

Move the perpendicular and semi-circle to the proper latitudes given, and the index until the distance sailed, marked on it, meets the perpendicular; then the index will mark the course N. 30° 10′ E. on the semi-circle.

To find the difference of longitude, screw fast the index to this course, move the perpendicular and semi-circle to the meridional parts of the given latitudes, and the space intercepted between the limb of the box and the index will shew the difference of longitude, 3° 30′.

By middle Latitude sailing.

Complement of middle Lat. 37° 20′.

Move

Move the semi-circle and perpendicular to the given latitudes, and the index until the distance sailed, marked on it, cuts the perpendicular; then the perpendicular will shew the departure 128 miles, and the semi-circle the course N. 30° 10′ E.

To find the difference of longitude, set the index to the complement of the middle latitude on the semi-circle, and move the perpendicular until the termination of the departure on it cuts the index; then the point of intersection will mark the difference of longitude, 210 miles, on the index.

CASE IV.

Both latitudes, and departure from the meridian, given, to find the course, distance, and difference of longitude.

Lat. 56° 40′ S. Long. 28° 55′ E. sailed from.
Lat. 61° 20′ S. arrived at. Departure 172 miles.

By Mercator's sailing.

N.B. In sailing through southern latitudes, the end of the cylinder where the numbers begin must

muſt be turned towards the north, pointed out by the ſemi-circle; and, in ſailing through northern latitudes, it muſt be reverſed.

Rule. Move the perpendicular and ſemi-circle to the proper latitudes given, and lay the departure on the perpendicular, then move the index until it meets the point in which the departure terminates: the diſtance will be marked on the index, 329 miles, and the courſe, S. 31° 35′ E. or S.S.E. ¾ E. nearly, on the ſemi-circle.

To find the difference of longitude, move the perpendicular and ſemi-circle to the meridional parts of the given latitudes, and the index will cut the difference of longitude on the perpendicular, 5° 35′.

By middle Latitude ſailing.

Complement of middle latitude 31° 00′.

Move the ſemi-circle and perpendicular to the given latitudes, and the index to the termination of the departure marked on the perpendicular; the interſection will ſhew the diſtance, 329 miles, on the index, and the index the courſe on the ſemi-circle, S. 31° 35′ E.

To

To find the difference of longitude, set the index to the complement of the middle latitude on the semi-circle, and move the perpendicular until the departure marked on it cuts the index, and this point of intersection will mark the difference of longitude on the index, 335 miles, or 5° 35′.

CASE V.

One latitude, course, and distance, given, to find the difference of latitude, and difference of longitude.

Lat. 56° 40′ S. Long. 28° 55′ E. sailed from.
Course S. 31° 35′ E. Distance sailed 329 miles.

By Mercator's sailing.

Set the semi-circle to the proper latitude sailed from, and the index to the course; mark the distance on it, and bring the perpendicular to the distance sailed, which, at the same time, will mark the latitude arrived at, on the line of proper latitude, 61° 20′ S.; screw the index to the course, and move the semi-circle and perpendicular to the

 meridional

meridional parts of both latitudes; then the index will cut the difference of longitude on the perpendicular, 5° 35′.

By middle Latitude sailing.

Find the latitude arrived at as above, and then find the difference of longitude, as found by middle latitude sailing in the preceding case.

CASE VI.

One latitude, course, and departure, given, to find the distance, difference of latitude, and difference of longitude.

Lat. 65° 40′ N. Long. 28° 55′ W.
Course N. 31° 35′ W. Departure 172. 7 miles.

By Mercator's sailing.

Move the semi-circle to the proper latitude sailed from, and the index to the course; mark the departure on the perpendicular, and move it until the termination thereof meets the index; then the point of intersection will shew the distance, 329 miles, on the index, and the perpendicular

dicular will shew the latitude arrived at, 61° 20′ N. on the base.

Then screw fast the index, and move the perpendicular and semi-circle to the meridional parts corresponding with both latitudes; then the index will cut the difference of longitude, 5° 35′, on the perpendicular.

By middle Latitude sailing.

Find the latitude arrived at, and the distance, as above, and the difference of longitude as in Case IV. by middle latitude sailing.

CASE VII.

One latitude, distance sailed, and departure, given, to find the course, difference of latitude, and difference of longitude.

Lat. 48° 30′ N. Long. 14° 40′ W. sailed from. Distance south easterly 345 miles. Departure 200 miles.

Move the semi-circle to the latitude departed from, mark the distance on the index, and the

 departure

departure on the perpendicular, move both until these points meet; then will the index shew the course, S. 35° 26′ E. on the semi-circle, and the perpendicular the latitude arrived at, 43° 49′ on the base.

The difference of longitude is found as in the preceding case.

By middle Latitude sailing.

The course and latitude arrived at are found as above, and the difference of longitude as in Case IV. by middle latitude sailing.

CASE VIII.

One latitude, course, and difference of longitude, given, to find the distance, and difference of latitude.

Lat. 48° 30′ N. Long. 14° 40′ W. sailed from.
Long. 9° 50′ arrived at. Course S. 35° 26′ E.

By Mercator's sailing.

Move the semi-circle over the meridional parts of the latitudes sailed from, and the index to the course,

course, and move the perpendicular until the difference of longitude marked on it meets the index; then the perpendicular will cut the meridional parts, on the cylinder, which correspond with the latitude arrived at; then bring the perpendicular and semi-circle to the proper latitudes, and the distance, 345, will be marked on the index by the perpendicular.

N. B. This case cannot be performed by middle latitude sailing; and, in sailing on a parallel, or where there is no difference of latitude made, the longitude cannot be had by Mercator's sailing, which makes it necessary to subjoin the two following cases.

CASE IX.

The difference of longitude between two places, in one parallel of latitude, given, to find the distance between them.

Lat. 49° 30′ N.
Difference of Long. 3° 30′ E.

Rule. Set the index to the complement of the latitude, 40° 30′, on the semi-circle, mark the difference of longitude in miles on the index, then move the perpendicular until it meets the termination of the difference of longitude on the index, and the part of the perpendicular intercepted between the limb of the box and the point of intersection will represent the distance required, 136.4 miles.

CASE X.

The distance between two places, in one parallel of latitude, given, to find the difference of longitude between them.

Lat. of the given parallel 49° 30′ N.
Distance sailed E. 136. 4.

Rule. Set the index to the complement of the latitude, 40° 30′, and mark the distance sailed on the perpendicular, and move it until it meets the index; then the point of intersection will shew the difference of longitude, 210 miles, or 3° 30′, on the index.

If it ſhould happen that the meridional parts of the given latitudes (36° and 44° N. Lat.) are not contained on the ſame line of the cylinder, but begin upon one and terminate on another, this difficulty is removed by ſliding the cylinder until the meridional degree of the latitude in 36° 00′ is brought near the extremity of the baſe, fixing the ſemi-circle perpendicularly over it, and moving the edge of the perpendicular to the termination of the graduations on the cylinder; then turn the cylinder until the continuation of the line required appears, and place the beginning of it to the edge of the perpendicular, where the former part of the line terminated, and move the perpendicular until it cuts the degree required; the ſpace intercepted between it and the ſemicircle will be the meridional difference of latitude ſought.

The Method of working a Traverſe.

Lat 46° 48′ N. Long. 7° 47′ W. ſailed from,

Courſes.		Diſtances.
S. S. W. ½ W.	—	24 miles.
S. b. W.	— —	36
S. ½ E.	— —	40

Required

Required the latitude and longitude arrived at, together with the direct courfe and diftance.

Set the femi-circle to the proper latitude departed from, 46° 48′, and the index to the courfe, S. S. W. ½ W. mark the diftance 24 on the index, and bring the perpendicular to meet it; then the index will cut the departure, 11.3, on the perpendicular, and the perpendicular will cut the latitude, 46° 27′ N. on the bafe. For the next cafe, bring the femi-circle to the latitude marked by the perpendicular, 46° 27′ and lay down the courfe S. b. W.; if it be towards the firft meridian, move the laft-marked departure until it meets the index, and the limb of the box will mark the prefent departure; but, if the courfe be from the firft meridian, bring the laft departure, 11.3, to the limb of the box, and the index will mark the departure made good, 18.3, on the perpendicular, and the latitude arrived at, 45° 52′, will be marked on the bafe by the perpendicular. Proceed in the fame manner with all the cafes of which the traverfe confifts; then the difference of latitude, 11° 36′ will be intercepted between the latitude failed from, 46° 48′, and the latitude arrived at, 45° 52′, laft marked

marked by the perpendicular; and alſo the departure made good will be intercepted between that point on the perpendicular where the firſt departure commenced, and that where the laſt terminated; then the courſe, S. 8° 30′ W. the diſtance, 97, and the longitude arrived at, 8° 8′, are found as in Caſe IV.

The Method of correcting dead reckoning.

CASE I.

If the courſe found by dead reckoning be leſs than three points, or 33°.

Lat. by obſervation departed from - 39° 18′ N.
Lat. by obſervation arrived at - 37° 48′ N.
Lat. by dead reckoning arrived at - 37° 31′ N.
Courſe by dead reckoning S. S. W. ¾ W.
Departure 64 weſterly.

Required the true difference of longitude.

Rule. With the courſe, S. S. W. ¾ W. and latitudes by obſervation, 39° 18′ and 37° 48′, find the

difference of longitude, 1° 9′, by Case II. of Mercator's, or middle latitude, sailing.

CASE II.

If the course found by dead reckoning be more than three points, or 33°, and less than five points, or 56°.

Lat. by observation departed from - 52° 40′ N.
Lat. by observation arrived at - 54° 22′ N.
Lat. by account - - - 54° 04′
Departure westerly 76 miles.
Required the difference of longitude.

Rule. With the latitude by observation 52° 40′, and latitude by account arrived at, 54° 04′, and the departure, 76, find the distance 113 by Case IV. of Mercator's sailing; and, with this distance, and latitudes by observation, find a second departure, 47.7, by Case III. of Mercator's sailing; and, with half the sum of these departures, 61.8, and the latitudes

tudes by obſervation, find the true difference of longitude, 1° 43′, by Caſe IV. of Mercator's ſailing.

CASE III.

If the courſe by dead reckoning be more than five points, or 56°.

Lat. by obſervation departed from - 38° 52′ N.
Lat. by obſervation arrived at - - 40° 18′ N.
Lat. by account - - - - - - 40° 00′ N.
Departure weſterly by account 112 miles.
Required the true difference of longitude.

Rule. With the latitude by obſervation departed from, 38° 52′, and that by account arrived at, 40° 00′, and the departure, 112, find the diſtance as above, 113; and, with this diſtance and the latitudes by obſervation, find the true difference of longitude, 2° 10′, by Caſe III. of Mercator's ſailing.

The advantages expected to ariſe from the uſe of this inſtrument are: Firſt, that no conſiderable miſtake can exiſt in the work, as the errors

become obvious, in proportion to their magnitude; whereas, in calculations, misplacing a single figure will produce an error of the greatest consequence. Secondly, this method does not rest on tables or logarithms, which abound in errors of the press, even in the best editions, and are often the source of much confusion. Thirdly, it will render the art of keeping a ship's reckoning easily learnt, and easily practised. Many masters of ships are persons who have been raised to that office from the lowest degree of seamen, who, from want of capacity, or want of early opportunities, have acquired only a very superficial knowledge of navigation; many, who have been better educated, disqualify themselves, by their riotous and dissolute lives, for the practice of this intricate branch of science. The accidents of the sea, and other emergencies, frequently render it necessary to commit the care of a ship to an ignorant sailor. In all these cases, the methods of calculating a ship's course, now in use, cannot be adopted or relied on with safety, and therefore such persons generally have recourse to the following dangerous alternatives.

In coaſting, and in ſhort voyages, they ſail by day, when they may ſee the land, ſhould they approach it, and *lie to* at night.

In longer voyages, they get into the latitude of the port ſailed to, by the aſſiſtance of their quadrants, and then ſail eaſt or weſt, (which they term *running down their longitude,)* until they *ſtumble,* as it were, on their object.

Every day's experience furniſhes inſtances of the melancholy effects of theſe contrivances; and, ſhould this ſcheme, on enquiry, be found capable of aſſiſting thoſe who are ignorant of better methods, it is humbly expected that the Academy will give their advice and countenance, as far as may be neceſſary, to bring it to maturity, and render it uſeful to ſociety.

EXPLANATION OF THE FIGURES.

(See Plate IV.)

The ſtock *a b c d* (Fig. 1.) is a parallelopiped; the length from *a* to *b* is two feet, the breadth from *a* to *d* two inches, and the depth is one

inch and a half. This ſtock is perforated longitudinally, ſo as to be capable of containing within it a cylindrical piece of timber *e f*, one inch in diameter. *g h* is an aperture, on the ſurface of the ſtock, about a quarter of an inch wide, which diſcloſes one twelfth part of the ſurface of the cylinder contained; the edge *d c* is divided into twelve parts, each of theſe are ſubdivided into ſix parts, and each of theſe are again ſubdivided into ten parts. The ſurface of the cylinder is divided longitudinally into twelve parts, and on each of them is engraved a portion of a line of meridional parts twenty-two feet long; which contains the meridional parts for every minute from the equator, as far towards the pole as ſailing is practicable, and the ſmalleſt diviſion on it is not leſs than $\frac{1}{20}$th of an inch: by rolling and ſliding this cylinder, any part of any line on it may be brought into any poſition which may be required. The box *i* is engrooved into the edge of the ſtock *a b*, ſo that it may move freely from *a* to *b*; a limb from this box extends to *k*, which ſerves to mark that degree of the perpendicular *i l* which is parallel to *m*, the centre of the ſemi-circle; *i l*

is

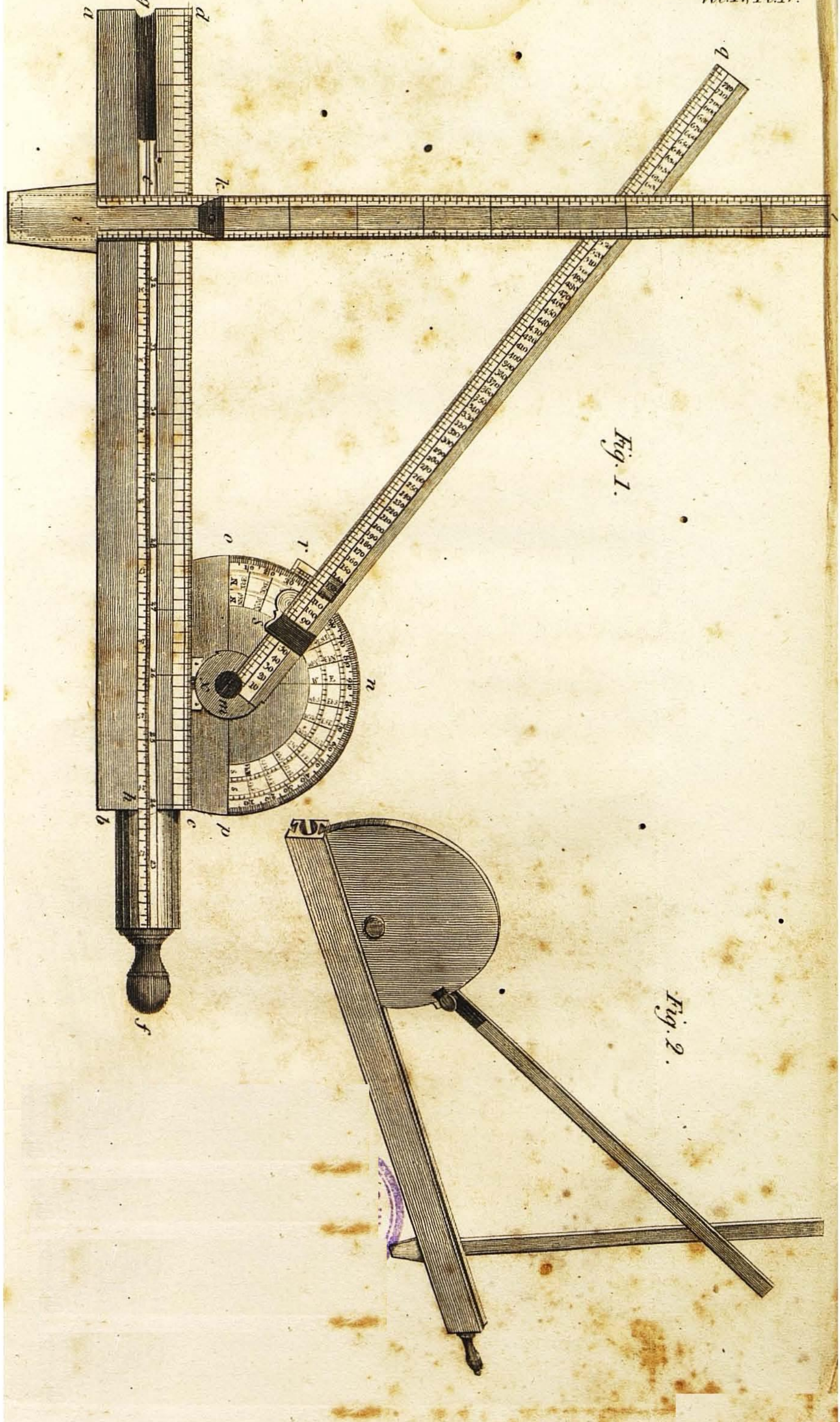


Fig. 1.

Fig. 2.

is two feet long, and graduated on both edges as the stock; it is perpendicular to the stock, and is fixed in the box *i*, by which it may be moved from *a* to *b*. *o n p* is a semi-circle of six inches radius, engraved as appears in the plate, which slides freely from *c* to *d*, in a groove in the edge of the stock *c d*. *m q* is the index, moving on the centre *m*, the edge of which marks the course on the semi-circle; it is two feet long, and divided into seventy-two parts, each of which are subdivided into ten parts, and are equal to the subdivisions of the lines on the stock and perpendicular; *r* is a nonius, attached to the index, to shew the minutes of the angle of the course *q m o*. *s* is a nonius, composed of concentric semi-circles, which slides along the edge *q m*, to the intersection of the perpendicular and index, where it serves as a nonius to both. Below *x* is a small piece of ivory, with a mark on it, to point out the degree of the line *d c* which is perpendicularly under the centre of the semi-circle.

Fig. 2 is a view of the back part of the instrument.

IX.

IX. *Analysis of the Copper with which the Ancients made their Coins, and their Cutting-Instruments; by M. Dizé, Member of the Royal Society of Biscay.*

FROM THE *JOURNAL DE PHYSIQUE.*

THE Abbé Mongez, wishing to know what were the means employed by the ancients to harden their copper, and render it fit for cutting, desired me to analyze a piece of a dagger made of ancient copper. He could only furnish me with a quantity which weighed twenty-five grains; the colour of which was a yellowish white; the surface, when broken, appeared like that of a brittle metal; and the grain discovered very plainly that the metal of which the instrument was made had been melted, and cast in a mould. I dissolved this small quantity in nitrous acid; the solution was very soon accomplished, but there remained a small quantity of white powder, which the

the nitrous acid was unable to dissolve. This white matter was washed, and dried; and I then exposed it to the heat of a blow-pipe, with some black flux; by this I obtained a small globule of a very malleable white metal, which appeared to me to be tin. This observation encouraged me to pursue my analysis upon a larger quantity of copper; to which end, the Abbé Mongez gave me eight different sorts of coins, Greek, Roman, and Gallic; they were all, except the Gallic, covered with a pretty thick coat of verdegris; and they were of various sizes.

Roman Coins.

No. 1. Was an ancient coin of red copper; I had great trouble to break it; when broken it had the appearance of a sufficient malleable copper. It weighed one hundred and fifty grains.

No. 2. A coin of copper less red than the former; its colour was very pale. It broke with violence under the sheers; and its broken surface was that of a very brittle metal. It weighed one hundred and fifty grains.

No. 3.

No. 3. A coin of copper which had the same properties as No. 2, except that it was rather more malleable. It weighed one hundred and fifty grains.

No. 4. A coin of a more brittle copper than any of the preceding. It weighed three hundred grains.

No. 5. Was almost malleable. It weighed two hundred grains.

Greek Coins.

No. 6. Were Greek coins, of a harsh and brittle copper. They weighed three hundred grains.

Gallic Coins.

No. 7. This coin was of a very brittle copper. It weighed fifty grains.

No. 8. A coin of a copper still more harsh and brittle. The broken surface of this coin did not appear to the eye at all similar in colour to the others; on the contrary, it had rather the appearance of broken steel, but was a little darker. It weighed fifty grains.

I dis-

I dissolved these eight kinds of coins, separately, in nitrous acid; when the dissolution was finished, I made the liquor boil. There remained, in each vessel, a quantity of white powder, which varied in its proportion, being more or less, according to the nature of the coins.

I poured off the solutions; the residuums were washed in a great quantity of water, and afterwards dried in glass vessels. The weight of each residuum was as follows.

No. 1 left a residuum which weighed $1\frac{3}{4}$ grains.

2 ————————	$22\frac{1}{2}$
3 ————————	$15\frac{1}{5}$
4 ————————	26
5 ————————	1
6 ————————	$16\frac{3}{4}$
7 ————————	$6\frac{1}{2}$
8 ————————	17

These residuums, treated with black flux, produced a white malleable metal, which was very easily dissolved in marine acid. The solution precipitated gold, from aqua regia, of a purple colour; a certain proof that this metal was tin.

Gold, being precipitated of a purple colour, by a ſolution of this metal, proves, as is before mentioned, that the reſiduum of each ſolution is tin; but if, as is aſſerted, the nitrous acid, in decompoſing itſelf, calcines tin, and the metal, by this calcination, while it loſes its metallic ſtate, increaſes in weight, in proportion to its combination with the baſe of vital air produced by the decompoſition of the acid; then the weight of each reſiduum does not give the real quantity of tin which the ancients added to the copper they uſed for fabricating their arms and coins. In order to find the real quantity, I calcined, by means of nitrous acid, one hundred and fifty grains of pure tin; I cauſed the mixture to boil for ſome minutes, that I might be ſure all the tin was calcined. The next day this matter was mixed with water, and thrown upon a filtre; it was then well waſhed in cold water, and afterwards perfectly dried. It weighed two hundred and nine grains; conſequently, the tin had increaſed in weight fifty-nine grains. This increaſe of

of weight is in the proportion of thirty-nine grains and three quarters in one hundred *.

From this reſult, it became eaſy for me to determine the real quantity of metallic tin contained in each kind of coin. This is ſhewn in the following table †.

No.	Which weighed (Grains.)	Left of tin calcined by nitrous acid. (Grains.)	Which was produced by a quantity of metallic tin, weighing (Grains.)	Proportion of tin in a hundred pounds of copper. (Pounds.)
No. 1	150	$1\frac{3}{4}$	1	$\frac{5}{6}$
2	150	$22\frac{1}{2}$	$16\frac{1}{6}$	$10\frac{2}{9}$
3	150	$15\frac{1}{5}$	$10\frac{3}{4}$	$7\frac{1}{6}$
4	300	26	$20\frac{3}{4}$	9
5	200	1	$\frac{5}{6}$	$\frac{5}{12}$
6	300	$16\frac{3}{4}$	$12\frac{1}{46}$	$4\frac{1}{138}$
7	50	$6\frac{1}{2}$	$4\frac{1}{8}$	9
8	50	17	$12\frac{1}{6}$	$24\frac{1}{3}$

Having proceeded ſo far, I thought it of conſequence to diſcover whether I could, according

* According to the quantities before ſtated this ſhould be thirty-nine grains and one third.

† We have printed this table as it is in the original, but we think it right to obſerve, that, if the quantities of the third column are correct, thoſe of the fourth and fifth are moſt of them erroneous; none of them indeed are very far from the truth, except thoſe of No. 4 ($20\frac{3}{4}$ and 9) both of which, eſpecially the latter, are much too high. Theſe errors, however, do not affect the general reſults of the experiments.

 to

to the refult of my calculation, make a copper, by *fynthefis*, which fhould have the fame properties as that of the ancients. I had taken the precaution of keeping a fmall piece of each coin, to ferve as an object of comparifon.

I made eight mixtures of copper and tin, in the order and proportions above ftated; from which I obtained eight kinds of copper, more or lefs brittle, and perfectly fimilar, in colour and malleability, to the famples I had kept for comparifon, and which I had endevoured to imitate. The proportions I made ufe of were fo juft, that the mixture which was made to imitate the Gallic coin No. 8, the moft brittle of the whole, is fo exactly fimilar to the copper of the coin itfelf, that one might be miftaken for the other.

I precipitated the copper, from folutions of thefe mixtures in nitrous acid, by fixed alkali; the precipitates, after being wafhed and tried, were reduced by means of the black flux, and I procured from each a lump of red malleable copper.

M. Geoffroy, jun. has afferted, that the ancients hardened their copper by mixing iron with it; that he had found that a fixth part of iron gave it the

the hardneſs, and alſo the grain, of the ancient copper; and that, by mixing iron with copper, in the forementioned proportions, he had been able to make a cutting inſtrument.

It is true that iron, by being mixed with copper in certain proportions, renders it hard and brittle; but, in equal proportions, it does not alter its colour ſo much as tin. I have mixed copper and iron together, in all proportions of the latter, from $\frac{1}{6}$ to $\frac{1}{81}$; but none of theſe mixtures reſembled the metal of the antient coins: it appears therefore that M. Geoffroy was miſtaken in his opinion. Beſides, nitrous acid diſcovers iron in copper, even when there is only the $\frac{1}{81}$ part; and a ſtill ſtronger proof againſt M. Geoffroy's opinion is, that iron when mixed with copper, from $\frac{1}{6}$ to $\frac{1}{76}$, is acted upon by the magnet. In the laſt mentioned proportion the copper is malleable, and loſes none of its colour: in the proportion of $\frac{1}{81}$ the iron is no longer diſcoverable by the magnet.

M. Monnet was inclined to think, that the copper of the ancients owed its hardneſs to the quantity of arſenic which remained in it, and which they did not know how to deprive it of: but, I am

am ſure that M. Monnet, if he had analyzed ancient copper, would have changed his opinion. I have made various mixtures with copper and regulus of arſenic, the reſults of which are as follow.

1. With two parts of copper and one of regulus of arſenic, the copper becomes as white as ſilver, and ſo brittle that it may be beaten to powder.

2. With one fourth part of regulus of arſenic, it is leſs white.

3. With one eighth it acquires nearly the colour of the antient copper.

4. With one ſixteenth it keeps its natural colour.

5. With one twenty-fourth, and one thirty-ſecond, it is pretty malleable.

The arſenic may be ſeparated from all theſe mixtures by nitrous acid, which diſſolves the copper, and leaves the arſenic. If, as M. Monnet ſuppoſes, the ancients were ignorant of the manner of ſeparating it, we ſhould find it in their coins, by treating them with nitrous acid; for the arſenic, as I have already obſerved, not being diſſolved by that acid, would be found mixed with

with the calx of tin. My mixtures of copper and regulus of arſenic, when treated with ſulphur, produced orpiment; none of which could be procured from the various calces of tin, left by the Greek, Roman, or Gallic coins, treated in the ſame way. Theſe laſt experiments, indeed, cannot be conſidered as concluſive, reſpecting a quantity of calx of tin which might contain a very minute portion of regulus of arſenic; (for inſtance, one hundredth of a grain;) in that caſe, to diſcover the preſence of this ſemi-metal, it muſt be thrown upon burning coals, and its peculiar ſmell immediately makes it known.

I am far from thinking that the ancients made uſe of a particular proceſs to deprive their copper of that portion of arſenic which is natural to it, but I believe that chance aſſiſted them in their metallurgic operations; for, it is well known that the operations copper undergoes, to bring it to a ſtate of perfection, ſerve alſo to free it from the ſulphur and arſenic which are generally mixed with it.

I think I have, from the reſult of my experiments, clearly ſhewn that the ſecret of tempering

 copper,

copper, of which the ancients were supposed to have been in possession, is chimerical; and that their copper owes its hardness merely to its being mixed with tin. This mixture forms what is called bronze, and certainly the antients knew the advantages resulting from it for casting their fine statues; particularly its resisting the action of the air. What appears to me singular is, the variation in the proportions of these metals in the coins of the Greeks and Romans; some containing more tin, some less. The Gauls seem to have been more constant in their proportion of tin; for, in their coins, we find it always nearly the same; and that proportion is exactly such as we make use of to form our bell-metal.

In addition to the inaccuracies, already mentioned in this paper, we cannot help pointing out two assertions of the author, in the last paragraph, which by no means agree with his experiments. First, that the proportion of tin in the Greek coins is various; whereas, all the Greek coins he tried were made the subject of *one* experiment. (No. 6.) Secondly, that the proportion of tin in the coins of the Gauls is always nearly the same; yet, according to his experiments, No. 8 contained almost theee times as much as No. 7. The proportion of tin in the former is nearly that of bell-metal.

REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER XX.

X. *Specification of the Invention or Discovery of the Use and Application of certain Vegetables, for dying, ſtaining, printing, and painting, certain valuable Colours.*

From an Act of Parliament, made in the 25th Year of his preſent Majeſty's Reign, for veſting in Edward Bancroft, of Villiers-ſtreet, York-buildings, Doctor in Phyſic, his Executors, &c. the ſole Property of the above Invention or Diſcovery.

To all to whom theſe preſents ſhall come, &c. Now I the ſaid Edward Bancroft, in obedience

 and

and conformity to the ſaid Act, do hereby particularly deſcribe and aſcertain the nature of my ſaid invention, in its improved ſtate, as followeth; I do declare, that the vegetables, of which I have invented or diſcovered the uſe and application, for the purpoſes of giving colour by dying, ſtaining, printing, and painting, as before mentioned, are the following three in number; *viz.* The firſt is a ſpecies of oak, growing ſpontaneouſly on the Continent of North America, and particularly within the thirteen United States, in ſome of which, particularly in the Maſſachuſets Bay, it is commonly called *yellow oak*, and in others, particularly in Pennſylvania, *black oak*; being that ſpecies of American oak which, in the writings of the celebrated Carolus Linnæus or Linné, is termed *Quercus nigra*, and which, in the Flora Virginica of Gronovius, is diſtinguiſhed as *Quercus foliis cuneiformibus, obſolete trilobis, intermedio æquali.* The bark of this oak is the part moſt uſeful in giving colour: it is very rough, and of a dark brown or black colour on the outſide, and of a light yellowiſh brown within; and may be diſtinguiſhed from the bark of all other oaks, with which I

am

am acquainted, by the following circumſtances or effects; *viz.* if boiled in water, its decoction becomes yellow by the addition of alum, or if, inſtead of alum, a ſuitable quantity of green vitriol, or other ſolution of iron, by ſome other mineral or vegetable acid, be added, it produces a kind of olive, or olive-brown colour, inſtead of a black, which would be thereby produced with the decoction of any other kind of oak known to me. There are ſeveral varieties of this ſpecies of oak, all agreeing with it in giving a yellow colour by the help of alum, and I claim the excluſive right in dying, &c. of all the oaks, and varieties of oak, poſſeſſing this property. The bark in queſtion may be moſt advantageouſly peeled or ſeparated from the tree in the ſpring months; and, as its rough blackiſh outſide part, making nearly half of the whole, contains little or no colouring matter, it may be ſhaved or cut off from the inner part; and this inner part, being thoroughly dried, and coarſely ground, may be cloſely packed and preſſed in proper caſks, and ſhipped; the ſpaces between the ſeveral caſks being filled with pieces of the ſame bark, ſhaved, but not ground. The

cargo which I imported, in the Brigantine Induſtry, Henry Hubbs, Maſter, from Philadelphia to London, in the year 1775, (at which time no other perſon had ever either imported or uſed this bark in Great Britain,) was ſhaved, prepared, and packed, in theſe ways, and I conſider them as a part of this my invention. The bark, thus prepared and imported, I call *Quercitron* bark, a name compoſed of the Latin words *Quercus citrina*; the colouring parts and particles of this ſpecies of oak are of that claſs which Meſſieurs Macquer, Fourcroy, Morveau, and other French chemical writers, have called *Extractive ſavonneuſe ou gommeuſe*, and are to be fixed in dying, &c. by what theſe writers, and the French generally, call *Mordants*; a term which I here adopt from, and uſe in, the ſenſe in which it is uſually employed by them, ſignifying alum, and other mineral ſalts and metallic ſolutions; the earths of one or more of which, being previouſly conveyed, by an aqueous vehicle, into the pores or interſtices of the ſubſtance to be dyed or coloured, do attract the colouring particles of the *Quercitron* bark, &c. diſſolved and applied in water, and do

fix

fix them, more or leſs indiſſolubly, in the ſubſtance thus dyed or coloured. The tingent particles of this oak, or *Quercitron* bark, very much reſemble, in their properties and effects, thoſe of the Weld or Would plant; (the *Reſeda Luteola* of Linnæus;) and all the colours, and variations of colours, which are communicable by it to wool, ſilk, cotton, linen, &c. may be given, I think more advantageouſly, by the *Quercitron* bark, uſed in the ſame ways, and with the ſame means; excepting, that as this bark, ſeparated from its outſide uſeleſs part, as before mentioned, and powdered, will yield about ten times as much colour as an equal weight of the Weld plant, it muſt be employed in a proportionably leſs quantity; and excepting alſo, that no pot or pearl-aſh, or any other alkaline ſalt, is to be employed with the *Quercitron* bark, when either a yellow or green colour is wanted from it; and that, in thoſe caſes where tartar, or cream of tartar, is uſed along with alum, for dying ſilk or wool yellow or green by the Weld, the tartar is to be wholly omitted in giving thoſe colours from the *Quercitron* bark, and the proportion of alum increaſed about one fourth part.

This

This general explanation will enable the dyers and callico-printers to produce, from the *Quercitron* bark, all the colours and effects which have hitherto been produced by the Weld plant; but, to prevent the possibility of any mistake, I shall subjoin a few particular directions, though convinced that they must be unnecessary. The callico-printer who would give a durable yellow from the *Quercitron* bark, instead of the Weld, must print or apply the same mordant, or composition of alum, sugar of lead, &c. (thickened as usual with gum,) which is employed in fixing yellow from Weld, upon or to linen or cotton, prepared in the usual manner; which mordant, having remained and dried on the spots or figures intended to be made yellow, the usual time, is to be washed or rinsed off in the usual manner, and then to be dyed with the *Quercitron* bark, (coarsely powdered,) in the same manner as is practised with the Weld; using however only a tenth part of the weight of the Weld which would be requisite, and employing a moderate heat, in which the parts printed with the mordant will receive a very good yellow, while the rest of the linen or cotton is scarcely

 dis-

diſcoloured. When a boiling heat is uſed, and long continued, a portion of the reſinous part of the *Quercitron* bark is thereby extracted, which, in ſome degree, tends to give the yellow a browniſh hue, and the parts intended to remain white are unneceſſarily diſcoloured, and conſequently require longer bleaching; the proceſs of which is to be conducted in the ſame manner, where the *Quercitron* bark has been uſed, as if the Weld had been employed. The ſame mordant to figures, &c. previouſly dyed or ſtained blue with indigo, will afford a green colour from the *Quercitron* bark, by the ſame proceſs as that which affords the yellow; and, when this mordant has been printed on a white ground, if, inſtead of the *Quercitron* bark, a portion of prepared madder be uſed with it, in the ſame manner as for the yellow, a laſting orange-colour may be produced, partaking more or leſs of the red, according to the greater or leſs proportion in which the madder is employed. If a ſuitable proportion of green-vitriol, or what is called iron-liquor, or of iron diſſolved in the nitrous or the marine acid, be mixed with the mordant directed for the yellow,

the

the *Quercitron* bark will, by the ſame proceſs, give an olive, or an olive-brown, with what the French call *Merde d'Oie*, carmelite, and other variations of that ſpecies of colour; and if the colour of the *Quercitron* bark is wanted to be ſtill more ſaddened, the iron-liquor alone may be uſed as the mordant; or, in its ſtead, a ſolution of iron by either of the mineral acids, being firſt ſufficiently diluted with water, and thickened with gum, as uſual, may be employed. The callico-printers may alſo give a conſiderable variety of earthy browns, ſnuff colours, &c. from the *Quercitron* bark, uſed in the ſame manner, by employing or ſubſtituting, as mordants, either of the ſeveral ſolutions of tin, biſmuth, or lead, in nitrous acid, (commonly called aqua fortis,) or the ſolution of zinc in marine acid, (commonly called ſpirit of ſea-ſalt,) or in aqua regia, or in vitriolic acid, (by which laſt what is called white vitriol will be obtained,) or by employing a ſolution of regulus of antimony in aqua regia; in preparing either of theſe mordants, the acid is to be ſaturated with the metal or metallic ſubſtance, (by being made to diſſolve as much as it can retain of it,)

and

and the ſolution is afterwards to be diluted with water, ſo as that the acid may be thereby reduced, and made weaker than that of lemon-juice, in order that it may not injure the linen or cotton to which it is to be applied. The mineral acids being prepared and ſold of very different degrees of ſtrength, it is impoſſible for me to ſpecify exactly the portions of the ſeveral metals, or metallic ſubſtances, above mentioned, which they are capable of diſſolving or retaining; and it is equally impoſſible for me here to aſcertain the exact proportion which will ſufficiently dilute theſe different ſolutions; though, in general, a mineral acid of ſuch ſtrength as to neutralize about its own weight of clean, dry, fixed vegetable alkaline ſalt will, when ſaturated with the proper metallic ſubſtance, as before mentioned, require near ten times its weight of water to dilute it ſufficiently for printing, for which laſt purpoſe it is to be thickened with gum as uſual. It may alſo be obſerved, that when either tin, or biſmuth, is to be diſſolved by the nitrous acid only, the acid ſhould be previouſly diluted by two or three times its weight of water, and the tin, or biſmuth, put

into the acid by ſmall quantities at a time, allowing the firſt quantity to diſſolve before a ſecond be added, otherwiſe the acid will act with ſo much violence as to calcine rather than diſſolve the metal. It is of great utility in the printing of linens or cottons, inſtead of applying the mordant previouſly, or ſeparately from the tingent or colouring ſubſtance, to be able to mix and apply both together by the pencil, or by printing; and for this purpoſe the *Quercitron* bark may be made ſingularly uſeful; a pound of it powdered may be boiled with two or three quarts of water, ſo as that, when ſtrained, the decoction will be reduced to one quart, and this, being thickened with the uſual proportion of gum, may be thoroughly mixed with one ounce and a half of ſpirit of ſea-ſalt, (ſtrong enough to neutaralize its weight of pure fixed alkaline ſalt,) in which as much tin as it is capable of diſſolving, by a moderate heat, has been previouſly diſſolved, and alſo with one ounce of ſpirit or oil of vitriol, of equal ſtrength, in which as much tin as it can retain has likewiſe been diſſolved, and alſo with one ounce and a half of double aqua fortis, of equal ſtrength, in

which

which as much lead as it can retain has been dissolved, and also with one ounce of that preparation of arsenic, which Macquer calls *Sel neutre arsenical.* And this mixture, being printed or pencilled upon linen or cotton, (prepared in other respects as usual,) and suffered to remain some days, until thoroughly dried, before it be rinsed or washed, will afford the most beautiful high bright yellow, capable of resisting, and even improving by, the action of lemon-juice, and also of resisting the action of soap and water, even in a boiling heat, for a longer time than any of the fast yellows given, even in any way, to linens or cottons from the Weld plant. And, though this yellow will acquire a brownish hue from exposure to the sun and air, it is by such slow degrees, and the stain is in other respects so durable, that this mode of employing the *Quercitron* bark will doubtless be highly useful to callico-printers. It is a constant effect of tin, when dissolved by the marine acid only, and employed as a mordant, to produce, with the *Quercitron* bark, a clear, lively, but palish, yellow, which is not very durable. The same metal, dissolved in nitrous acid only,

produces from the *Quercitron* bark a durable kind of nankeen brown; and, diſſolved in the vitriolic acid, it produces from the *Quercitron* bark a yellowiſh brown. If either of the two laſt ſolutions of tin be mixed with an equal portion of the ſolution of that metal by marine acid, of equal proportionable ſtrength, (I mean capable of neutralizing an equal quantity of fixed alkaline ſalt,) and this mixture be uſed as a mordant for the *Quercitron* bark, it will produce a colour better, and more laſting, than could be obtained by a ſolution of tin in marine acid only. If, inſtead of equal portions of the before mentioned ſolutions, a little more of the nitrous or of the vitriolic ſolutions of tin be added to the ſolutions of that metal in the marine acid, and this laſt mixture be employed as a mordant, and applied, either ſeparately from the *Quercitron* bark, to the linen, cotton, &c. or mixed with a decoction of the bark, a moſt beautiful high bright yellow will be produced, which, in a very extraordinary manner, reſiſts the action both of acids and of alkalies; but it is more liable to become brown from the ſun and air than either of the preceding yellows. If, to a decoction

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of *Quercitron* bark, made and gummed as has been before defcribed, a folution of iron by fingle aqua fortis be added as a mordant, this mixture, printed or pencilled on linen or cotton, will afford different fhades of lafting *Merde d'Oie*, olive, and olive-brown colours, according to the proportion of iron fo employed; and if, inftead of this mordant, a folution of bifmuth, or of lead, in aqua fortis, or of zinc, or regulus of antimony, in aqua regia, be mixed with the fame decoction, a confiderable variety of earthy browns, fnuff colours, &c. may be given, which will refift acids, foap, and the action of the fun and air, fo as to be very ufeful to callico-printers. Thefe feveral metallic folutions, when intended for this ufe, are to be made in the fame way, and employed in about the fame degree of ftrength, as was drected when they were intended to be applied feparately to the linen or cotton, inftead of being mixed with the decoction of the *Quercitron* bark. The dyers of linen and of cotton manufactures will hardly need to be told, that the fame means which enable the callico-printers to give ftains or colours partially, will enable them, the dyers, to give the fame

ftains

ſtains or colours generally; and that the *Quercitron* bark, with the mordants propoſed for fixing or varying its colour, will dye all the colours, and ſhades of colour, before mentioned; with this difference, that it will always prove moſt advantageous to theſe dyers, to apply the mordant, without gum, previouſly to the piece of linen or cotton to be dyed, and ſuffer it to remain ſome days, the more the better, ſo that it may be very thoroughly dried and conſolidated in the pores of the linen or cotton before it be rinſed off; after which it is to be dyed as uſual with the *Quercitron* bark, in powder, allowing about one pound of it to every nine or ten pounds which the linen or cotton weighed when dry. Or theſe dyers, if they think it preferable, may uſe the *Quercitron* bark in the ſeveral ways in which they employ the Weld plant, and produce thereby the ſame effects, allowing for its ſuperior proportion of tingent matter, and avoiding, as has been before obſerved, the uſe of any fixed alkaline ſalt, and of tartar, where either a yellow or a green is to be produced. The ſame obſervation is to be repeated to the woollen dyers generally, with one ſingle example;

example; *viz.* to dye one hundred pounds of cloth, or of wool, of a bright, good, yellow colour, it is to be boiled the ufual time, with the ufual proportion of water, and about eighteen or twenty pounds of alum, but with neither tartar nor cream of tartar; after which, being flightly drained or preffed, the cloth or wool is to be removed to another fuitable veffel, in which ten or twelve pounds of *Quercitron* bark, powdered and tied up in a fuitable bag, fhall have previoufly boiled for a quarter of an hour, with the ufual quantity of water, with which the cloth or wool is to be dyed, in the fame manner as is practifed with the Weld plant, but without any alkaline falt, or lime. When weaker fhades of yellow are wanted, the quantities of alum and of *Quercitron* bark are to be proportionally diminifhed. Cloth or wool previoufly dyed blue, of different fhades, may in thefe ways acquire the various fhades of green; or of orange, if previoufly dyed of fuitable reds. In other cafes, the colour of the *Quercitron* bark may be faddened and varied, by the woollen dyers, by the feveral ways and means which they employ to fadden and vary the co-

lours

lours of Weld. Silk, prepared in the ufual way, may be dyed of the feveral colours before mentioned from the *Quercitron* bark, by the fame means, and in the fame ways, as are directed for wool, but with lefs heat, as is ufual; or it may be partially ftained, or fpotted, by the decoction of *Quercitron* bark, mixed with the feveral metallic folutions or mordants, mentioned for producing the like effects on linen or cotton. Hair and fur are to be dyed from the *Quercitron* bark, in the fame manner, and by the fame means, as are defcribed for dying wool; and fo is leather, excepting that care muft be taken to employ but a very moderate heat with it. To ftain paper yellow, a quart of decoction of *Quercitron* bark, made in the fame manner, and of the fame ftrength, as has been defcribed for the callico-printers, may be mixed with about half a pound of alum, and this, being diffolved, may be thickened and applied in the ufual manner; or, if a more opake fubftantial colour be wanted, fo much chalk, or calcareous earth, may be added to the decoction, as will neutralize the acid of the alum in it. The other combinations and variations of this colour, may be

produced

produced by the ſame means which the paper-ſtainers now employ, to produce the like effects with the other yellows commonly uſed by them. There is moreover contained in the *Quercitron* bark a reſinous colouring part, which water alone cannot diſſolve or extract, but which may be extracted by it, with the help of about one pound of American pot-aſh, or other alkaline ſalt of equal ſtrength, to every twenty pounds of the bark, previouſly deprived of all the tingent matter which water alone can ſeparate from it. Four or five pounds of linen, or cotton, or ſilk, or wool, boiled with reſinous colouring matter thus extracted from a pound of the bark, and afterwards plunged into a ſufficient quantity of vitriolic acid, diluted with water ſo as not to injure the linen, &c. will acquire a kind of nankeen colour, which ſeems to be ſufficiently durable. The bark of the root of this ſpecies of oak, and its acorns, poſſeſs the ſame colouring properties as the bark of the trunk and branches, but in different proportions; the former being conſiderably more abundant than the latter in colouring matter.

The ſecond of theſe vegetables is the North American Hiccory or walnut-tree, termed by Linnæus *Juglans alba*; and deſcribed in the Flora Virginica of Gronovius as *Juglans alba, fructu minori, cortice glabro*, and alſo as *Juglans alba, fructu ovato compreſſo, nucleo dulci, cortice ſquamoſo.* There are ſeveral other ſpecies or varieties of this hiccory, the barks of which afford a yellow colour when boiled in water with alum, and I mean hereby to ſecure the uſe of all which are diſtinguiſhed by this property; which the rinds of the nuts, and the bark of the roots, of this tree, likewiſe poſſeſs. The tingent matter of the hiccory is of the ſame nature as that of the *Quercitron* bark, and is to be communicated or uſed, varied, and fixed, by the callico-printers, dyers, paper-ſtainers, &c. in the ſame ways, and by the ſame mordants, as have been deſcribed for uſing, varying, and fixing, the colours of the *Quercitron* bark, in or upon wool, ſilk, linen, cotton, paper, &c. Obſerving, however, that the hiccory bark affords about one fourth leſs of colour than the *Quercitron* bark, and that it is leſs ſuitable for

mixing

mixing directly with the ſeveral mordants, and printing or pencilling on linens or cottons, as is directed to be done with the decoction of *Quercitron* bark. The hiccory bark may be powdered, without ſeparating its outſide part, and preſſed into proper caſks, and thus imported for uſe.

The third of theſe vegetables is the Red Mangrove, growing ſpontaneouſly near the ſea, on the Continent and Iſlands of America, and in other parts of the globe, between the Tropics of Cancer and Capricorn. It is the *Rhizophora Mangle* of Linnæus, deſcribed by Sloane, Ray, and other botanic writers, as the *Mangle pyri foliis, cum ſiliquis longis, ficui indicæ affinis.* The bark of this tree is of a reddiſh-brown colour, excepting only a very thin external coat, which cannot be eaſily ſeparated from the inner part, and therefore may be ground with it when thoroughly dried; and they may be packed, and imported, as is directed for the hiccory bark. As a colouring ſubſtance, the red Mangrove bark is of the claſs of thoſe whoſe tingent particles Monſ. Macquer, in his *Dictionnaire de Chymie,* deſcribes as reſiding partly

in a ſubſtance *ſavonneuſe extractive*, and partly *terreuſe et réſineuſe*, and therefore its colour may be extracted by water only, and communicated and fixed in wool, ſilk, linen, cotton, &c. without the help of any mordant whatever; I think however, that the colour of the mangrove bark is better extracted, and conſiderably improved, by adding pot or pearl aſhes to the water in which it is boiled, at the rate of about one pound of pot or pearl-aſhes for every thirty pounds of bark. Thus extracted, the colour of the mangrove may be permanently fixed in wool, ſilk, linen, cotton, &c. in the moſt ſimple manner, without the uſe of any mordant whatever. One hundred pounds of wool, or of cotton, or linen, may be thus dyed of a reddiſh brick colour, by being only boiled with five pounds of the mangrove bark, powdered, and two ounces of American pot or pearl aſhes; and the ſame quantity of ſilk may be alſo dyed by the ſame means, taking care only to employ a more moderate heat. One pound of mangrove bark, boiled with a thirtieth part of its weight of pearl aſhes, in a gallon of water, un-

til the decoction, when ſtrained, is reduced to three pints, or two quarts, being thickened with gum, may be printed or pencilled upon linen or cotton, and will thus give laſting ſtains, capable of reſiſting the action of acids, of ſoap, and of ſun and air, for a long time. The colour of this decoction may however be improved, varied, and, I think, rendered ſtill more durable, by the help of the ſeveral mordants directed for varying and fixing the colour of *Quercitron* bark. The ſolutions of iron, in different proportions, ſadden, and if uſed in ſufficient quantity, produce a black, with this decoction of the mangrove bark. About an ounce of the *Sél neutre arſénical* of Macquer, diſſolved in a quart of the ſame decoction, ſeems to give the colour more body and permanency. Lead diſſolved in aqua fortis, and mixed with this decoction, adds to the beauty and permanency of its colour. Tin diſſolved in vitriolic acid, and alſo in aqua regia, produces uſeful variations of its colour; as does biſmuth diſſolved in nitrous acid, and indeed all the other mordants directed for the *Quercitron* bark. But, as words can convey but

imperfect

imperfect ideas of the variations produced by them, and as some of their variations are very inconsiderable, it would be useless to attempt a more particular description of their effects, which may be seen by any person who will make the experiments. The callico-printers, who would thus print and pencil the colours of the red mangrove, may observe the directions already given, respecting the preparations and proportions of the several metallic solutions, or mordants, to be mixed with the *Quercitron* bark. The dyers of wool, silk, linen, and cotton, may advantageously employ all the several mordants, and also alum, and sugar of lead, to fix and vary the colours of the mangrove; and may employ them, either previously applied to the substance to be dyed, or mixed with the colouring matter of the mangrove, in the proportions and ways directed for the *Quercitron* bark; allowing only for this difference, that the mangrove contains about twice as much colouring matter as the *Quercitron* bark. The colouring matters of the foregoing vegetables, mixed with each other, and with other dying drugs, and fixed by the mor-

dants

dants herein before mentioned, are capable of producing many other variations of colour, which thoſe acquainted with the principles of dying and combining colours will readily conceive. Indeed almoſt every argillaceous and metallic ſolution which chymiſtry affords, is more or leſs capable of varying and of fixing the colouring matters of the preceding vegetables, though it would be uſeleſs and endleſs to point all the ways in which theſe ſolutions may be employed or combined for that end; thoſe which I have already ſpecified are probably more than will ever be practiſed, and they are the moſt uſeful reſults of ſeveral thouſands of experiments. In witneſs whereof, &c.

XI. *Specification of the Patent granted to Mr.* Anthony Bourboulon de Boneuil, *of Liverpool, in the County Palatine of Lancaſter; for his Invention of an Apparatus on a new Conſtruction, and certain new-invented Proceſſes, for the Purpoſe of making Foſſil Alkali; by which the many Obſtacles and Inconveniences attending the Methods hitherto uſed are remedied, and that very uſeful and important Article is obtained of a Quality equal to that extracted from the beſt Barilla.*

WITH A PLATE.

Dated March 11, 1789.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that, in compliance with the ſaid proviſo, I the ſaid Anthony Bourboulon de Boneuil do hereby declare, that my ſaid invention of an apparatus on a new conſtruction, and certain

certain new-invented proceſſes, for the purpoſe of making foſſil alkali, is deſcribed in the plan and deſcription thereof hereunto annexed. In witneſs whereof, &c.

Previous to ſpecifying my apparatus and proceſſes, I muſt obſerve that, to extract foſſil alkali from marine ſalt, two things are wanted: firſt, the materials containing the neceſſary principles; ſecondly, a proper apparatus for working them ſucceſſively. As for materials, I uſe ſuch as have been already uſed, I mean charcoal and iron, mixed and melted with Glauber's ſalt, into which marine ſalt is at firſt to be converted, and of courſe I claim no grant on that head. But I work thoſe materials in a manner, and with an apparatus new, hitherto unpractiſed, and (what is more material) quite neceſſary to ſucceed in ſuch an extraction of foſſil alkali, with ſuch or other materials. This improved apparatus and proceſs is the invention, in the enjoyment of which I claim to be ſecured under the patent. It conſiſts of what follows. Inſtead of keeping

the mixture of the materials lying in an open reverberatory furnace, expoſed to the violence of the fire, and the courſe of the air, I keep them in pots or crucibles B, (ſee Plate V.) made of iron, ſtanding upon a mere flat furnace A, ſuch as are commonly uſed for diſtillation, where their necks are raiſed a little above the ſurface of the furnace, and their mouths cloſely ſhut with the lids C; as appears by the plan. The empty places between each crucible are ſhut on the ſurface of the furnace, with breaks to prevent the fire from catching the materials, as the lids C are intended to prevent them from the contact of the exterior air; from theſe two improvements it happens, that the ſulphur formed at firſt, by the mixture of the vitriolic acid lying in the Glauber's ſalt with the principle lying in the charcoal, meeting with iron on every ſide, leaves the alkali, and turns to iron *; by which it is thus ſo ſtrongly kept, that a martial pyrite is inſtantly produced, and the foſſil alkali remains free, and ſtands by itſelf amidſt the pyrite. By former methods, the materials being

* Compared with the record in the office.

worked

worked in open reverberatory furnaces, and being ſo expoſed both to the violence of the fire and the courſe of air, it happens, that the fire, acting immediately and on every ſide upon the materials, burns the ſulphur as ſoon as it is engendered, and conſequently before it has turned to iron *; the vitriolic acid that becomes again free returns to the alkali, and re-produces Glauber's ſalt. To extract the foſſil alkali from the martial pyrite, by my method, the matter is poured from the iron crucibles into the iron pans E, and afterwards ſpread on the ground, where it is left till the martial earth into which it turns becomes effloreſcent; then the earth is elixiviated ſeveral times, and the water, having thus imbibed the alkali, is boiled, evaporated, and poured into proper pans, wherein the alkali goes out and chryſtallizes, like the beſt Barilla, which never can be obtained without iron crucibles, uſed in ſuch furnace, and with ſuch particular proceſs, as above ſpecified.

* Compared with the record in the office.

References.

(See Plate V.)

A. The furnace.

B. A crucible.

b b. Mouths of the crucibles when in the furnace.

C C. Lids or covers to the crucibles.

D. Spoon to extract the materials.

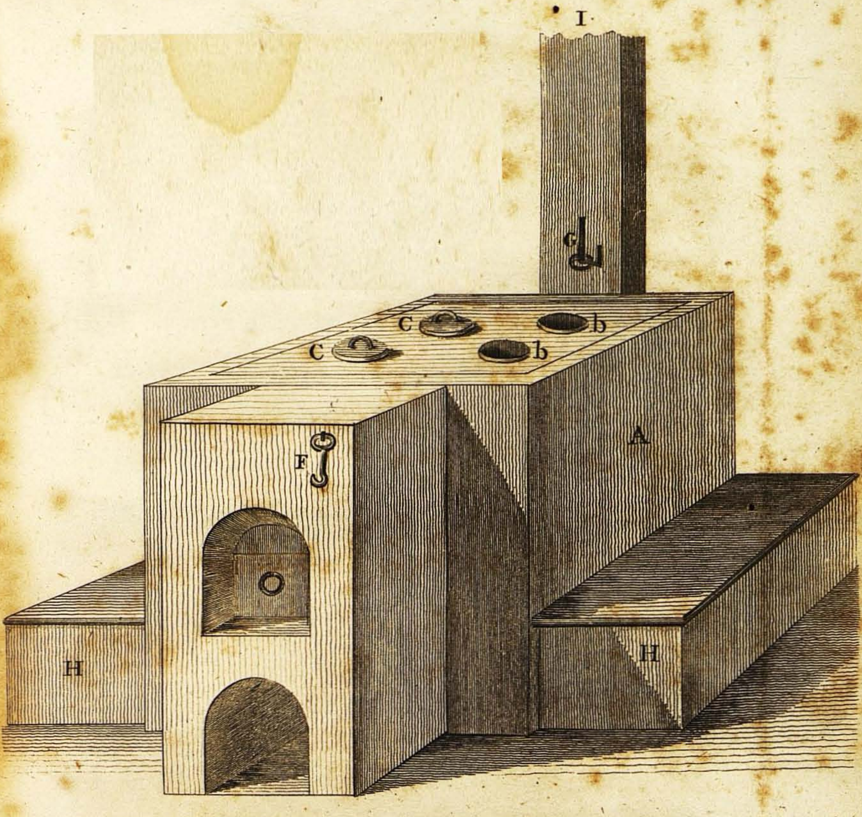
E. Veſſel to receive the materials extracted.

F. Hook to take off the covers, and take out the crucibles.

G. Regulator.

H H. Steps.

I. Chimney or flue.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XII. *Specification of the Patent granted to Mr.* ROBERT THORNTON, *of East-Smithfield, Chemist and Druggist; for his Method of reducing Malt and Hops into a solid Essence or Extract, for the Purpose of making Beer, at Sea, and in distant Climes and Countries.*

Dated April 15, 1778.—Term expired.

TO all to whom these presents shall come, &c. Now KNOW YE, that, in compliance with the said proviso, I the said Robert Thornton do hereby declare, that my said invention, of an entire new and particular kind of method of reducing malt and hops into a solid essence or extract, for the purpose of making good and wholesome beer, at sea, and in distant climes and countries, is performed and described in the manner following;

ing; that is to ſay, the new method of preparing an eſſence or extract of malt and hops is, by the tranſmitted heat of compreſſed vapour of boiling water, and a proper apparatus for that purpoſe. This apparatus may be made of iron, tin, or copper; it conſiſts of a boiler, of any dimenſions, a double veſſel, and conducting tubes. The double veſſel conſiſts of one veſſel placed within another, and fitted tight at their rims. The upper veſſel forms the upper part of the under veſſel, and contains the liquor to be evaporated. The under veſſel is every where incloſed, except at an aperture communicating with the boiler, and at another aperture communicating with the conducting tubes; and is conſtructed ſo as not to allow any part of the vapour condenſed into drops within it to eſcape, except back again into the boiler; it is not ſo extenſive as to act as a common refrigeratory, and yet is capacious enough to prevent the liquor boiling over. The aperture communicating with the boiler, is large enough to freely admit the vapour from the boiler into the under veſſel; and the aperture communicating with

with the conducting tubes, is of a proper size to allow of the vapour in the under vessel being compressed, to a degree capable of transmitting to the liquor to be evaporated a proper heat, and at the same time to serve as a passage for more heat than is necessary to keep up that degree of compression. The conducting tubes are to convey this superfluous heat or vapour, to be used for farther purposes, or immediately out of the building. In witness whereof, &c.

XIII. *Specification of the Patent granted to Mr.* GEORGE CHOUMERT, *of Five-Foot Lane, Bermondſey-Street, in the County of Surrey, Tanner; for his Invention of a Machine for cutting, ſplitting, and dividing, Hides and Skins, as well in the Pelt before dreſſed as when dreſſed into Leather, ſevering the Grain-ſide from the Fleſh-ſide.*

WITH A PLATE.

Dated Auguſt 7, 1783.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, he the ſaid George Choumert doth hereby deſcribe and aſcertain the nature of his ſaid invention, and in what manner the ſame is to be performed, by a plan or drawing hereunto annexed; (Plate VI.) that is to ſay,

ABCD. The frame.

E. The tongs or pincers, which hold the ſubſtance to be divided.

F. The roller which regulates the ſubſtance to be divided, to which are fixed tranſverſe chains.

GH. The rollers between which the ſubſtance to be biſected paſſes.

I. The knife, adjuſted by wheels and ſcrews.

KKK. The regulators of the knife, which are, parallel plates, and adjuſting ſcrews.

L. The frame, which is drawn by working the machine to and fro, and works the knife.

M. The index, which regulates the ſubſtance to be cut.

N. The barrel or roller which takes up the chain.

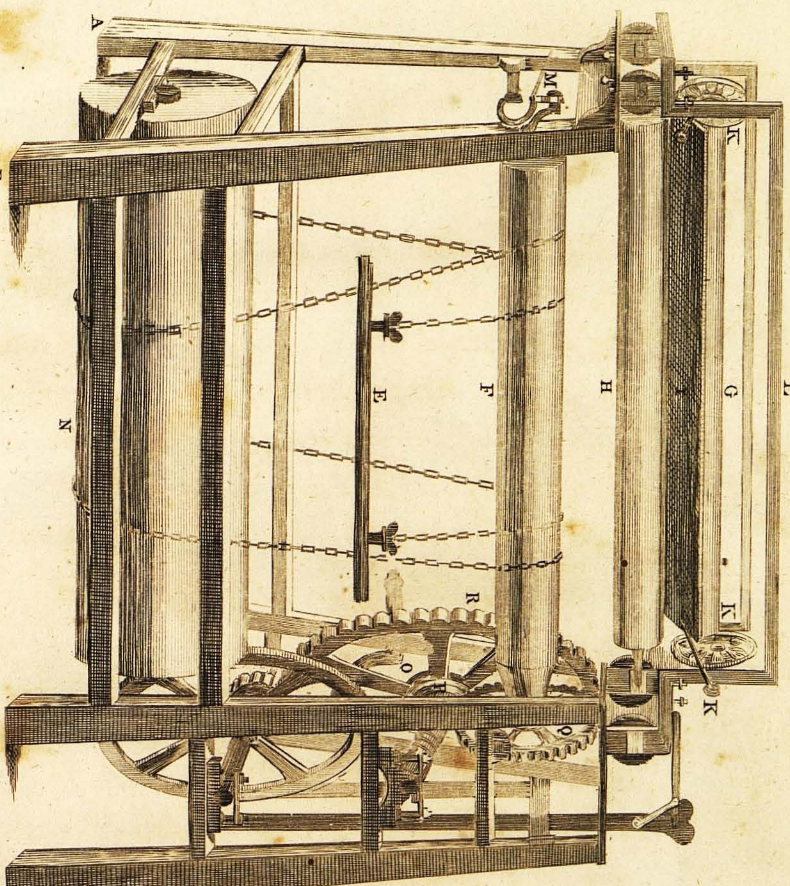
At the oppoſite ſide of the machine, at O, is a winch, on the axis P, which has a ſpiral worm, that turns the cog-wheel Q, which regulates the roller that draws the chain, to which are fixed the pincers; which chain, paſſing under the large roller N, ſecures and regulates the ſubſtance to

be divided. The axis of the winch has alſo a cog-wheel R fixed to it, which moves a multiplying-wheel, in which is fixed a ſtud, that gives motion to the balance-beam, that regulates and gives motion to the knife; on the axis of the excentric wheel is fixed the balance.

The regulator K is a plate-wheel, on which is fixed the movable limb, and a groove, in which the knife is fixed; under the rollers are, at each end, ſcrews, by which the ſubſtance to be cut may be regulated.

There are adjuſting-ſcrews, for the rollers between which the ſkin paſſes, and other ſcrews which keep the rollers ſteady in their places.

Motion may be effected with any other power. In witneſs whereof, &c.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XIV. *Description of a Churn upon a new Construction; by Mr.* WILLIAM BOWLER, *of Cambridge.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Thirty Guineas was voted to Mr. BOWLER for this Invention; the Description of which is preceded by a Letter from Mr. JAMES BERWICK, or Waltham Abbey, of which here follows an Extract.

THE bearer, William Bowler, has invented a churn, which is much superior to any of the churns now in use. My servant has been, for the two last times of churning, with the barrel-churn, ten or twelve hours, and I have known

farmers who have been two days before they got butter. Upon a fair trial with this new-invented churn, it produced good butter within the hour.

The churn itſelf is of the barrel kind, being a cylinder, eighteen inches diameter, and nine inches wide; the ſides wood, and the rim tin-plate; having two openings, the one eight inches and a half long by four inches wide, through which the cream is put into the churn, and the hand introduced for cleaning it; the other, a ſhort pipe, one inch diameter, by which the butter-milk runs out of the churn, when the operation is finiſhed. The firſt of theſe openings has a wooden cover, faſtened down by two ſcrews, and the other a cork fitted to it, while the butter is churning. There is alſo, near the larger opening, a ſmall vent-hole with a peg, to allow a paſſage for any air diſcharged from the cream at the beginning of the operation. An axle paſſes through the churn, terminating in two gudgeons, on which it hangs, its lower part being immerſed in a trough, to oc-

caſionally

caſionally hold hot or cold water, according to the ſeaſon of the year; and on the inſide of the rim are four projecting pieces of wood, with holes in them, ſerving to beat the cream by the motion of the churn. This motion is cauſed by a pendulum, three feet ſix inches long, having an iron bob, weighing ten pounds, and at its upper end turning a pulley, ten inches diameter, from which goes a rope twice round another pulley, about three inches diameter, fixed on the axis of the churn, and cauſing it to make a partial revolution by each vibration of the pendulum. There are ſliding covers to the machinery, and alſo a cover to the water-trough, in order, when hot water is uſed, to ſecure the ſteam, and ſteep the cream in a due and neceſſary degree of warmth. The motion of the pendulum is given and kept up by a wooden rod, about three feet nine inches long, turning on a pin about three inches above the bob of the pendulum.

Ex-

Explanation of the Figure.

(See Plate VII.)

A A. The body of the churn.

B. An opening, by which the cream is put in.

C. The cover of the large opening. The small opening on the opposite side of the churn cannot be shewn in the figure.

D. The gudgeon on which the body of the churn hangs.

E. The upper or larger pulley.

F. The smaller pulley, fixed on the axis or gudgeon of the churn.

G. The rod of the pendulum hanging from the upper pulley E.

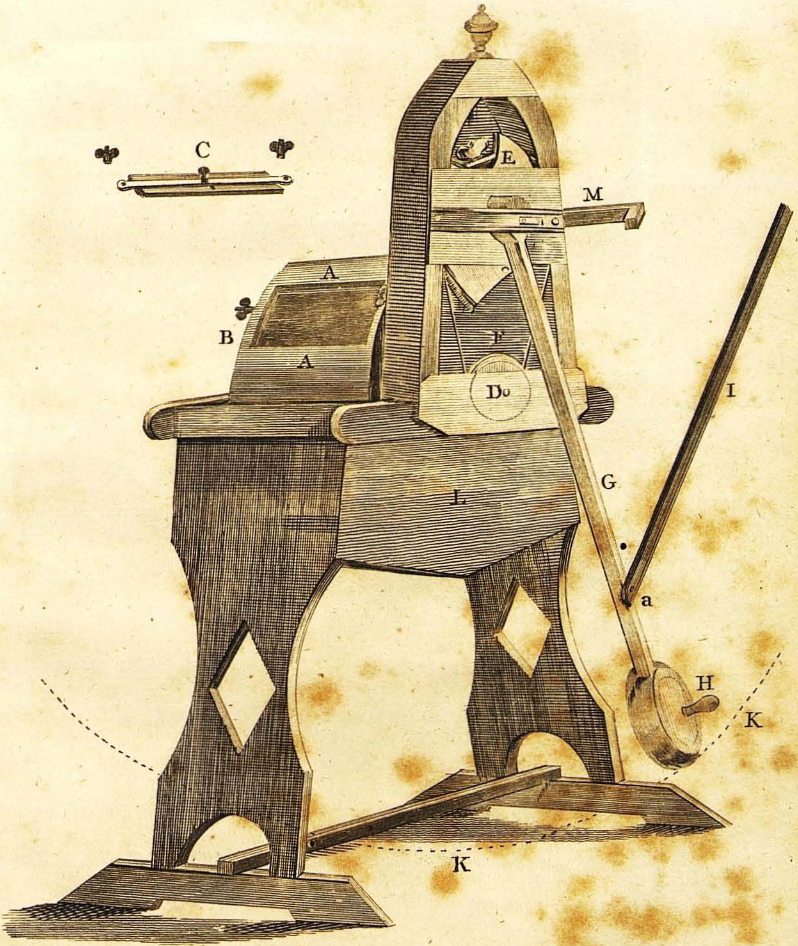
H. The bob of the pendulum.

I. The handle, movable on a pin at *a*, by which the pendulum is moved to and fro, making a traverse, in form of the dotted line K K.

L. The trough for the hot or cold water.

M. A projecting piece of wood, with a shoulder, by which the handle I is supported when the churn is not at work.

XV.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XV. *Description of a new-invented Method of writing and engraving in Oil, and multiplying Copies on Paper, Parchment, Linen, and other Materials of flexible Texture. In a Letter to the Editors, from Mr.* Samuel Toplis, *of Gainsborough.*

Have in readineſs a well-poliſhed ſilver, copper, braſs, or other metal plate; or a piece of ſmooth glazed, or unglazed earthen-ware; or a board, previouſly coated with copal, ſhell-lac, or any other hard varniſh; or a piece of horn, ſuch as is now uſed for glazing books; have alſo ready a cuſhion, made of the ſofteſt kind of leather, ſtuffed with moſs, wool, bran, hair, or other convenient article; or, as a ſubſtitute for the cuſhion, take a freſh bladder, of any kind of animal, wipe it with a cloth, and fill it with common air, in the uſual manner. On the cuſhion, or its ſubſtitute,

ſtitute, with a painter's bruſh, a knife, a folding-ſtick, or other convenient inſtrument, ſpread a fine coat of ſtrong printing-ink; or, if that cannot be eaſily procured, uſe paint, of any colour, or other ſubſtance of a viſcous nature, of ſuch a conſiſtence as will admit of a ſeparation without running. Take the plate, of whatever ſort, (holding it by the corners alternately,) and ſuffer it to touch the ink, paint, &c. by gentle pattings or fallings of the plate, till the whole become coated, the time for doing which, for a common-ſized ſheet of paper, will ſcarce ever exceed a minute. With a piece of box, or other hard wood, or even a common ſkewer, reduced to a point fit for making proper ſtrokes, (a thorn may be uſed as a ſubſtitute,) write, engrave, or delineate, the ſubject deſired; either backwards, (if that is not thought difficult,) or forwards, as is cuſtomary in common writing, holding a flat ruler in one hand, as a guide, and to prevent injuring the coating, while the operation is performing with the other.

The

The plate, thus coated, written, engraved, or delineated, muſt then be taken to a common rolling-preſs, ſtanding-preſs, or any other kind of preſs, or, for want of them, placed on a hard piece of ground, or a boarded floor. On the plate lay a dry or moiſt ſheet of paper, ſkin of parchment or leather, piece of ſilk, linen, or other material of flexible texture; on any of theſe lay a woollen cloth, that is to ſay, a blanket, or, as a ſubſtitute, the ſkirt of a coat, or other convenient article, and on that a proper-ſized board, flat ſtone, or other ſuch body, giving the required preſſure by your own weight, or by any other effort of art or ſtrength; there will then be found a fair copy of all matters written, engraved, or delineated, on the coated plate, appearing on the paper, &c. in white letters or characters. If more than one copy is required, by this ſimple yet effectual method, the force meant to be applied to the written or engraved plate muſt be divided by the number of copies wanted; three, if not four, are to be had this way, and perhaps a greater number may be

obtained by more general practice and experience.

As a distinct as well as new branch of the polite and liberal arts, engraving and writing in oil and oil-colours may also be applied to glass, and to earthen ware in general, with peculiar advantage and neatness, according to the abilities and genius of the present writers, (*i. e.* engravers,) in this kingdom; for which purpose the following rule is given, viz. if the letters, verses, ciphers, or other signatures, are desired to be of a colour opposite to that of the natural body or ground-colour of the vessel, or vessels, lay a coat of paint or varnish upon it; let it become dry or hard, and write or engrave in the second, third, &c. coat: but, if the ground-colour of the vessel be preferred, one coat, in general, will be found sufficient, and will be of considerable use.

Moreover, this invention is intended to convey useful knowledge, or the delineations of fancy, to the various parts of the habitable globe, in a different and more curious manner than by any other means that have hitherto been practised or

attempted;

attempted; as the art may be extended, through the mediums of painting, japanning, callico-printing, &c. &c. to all bodies poſſeſſing plain ſurfaces, of whatever ſhape or uſe, amid our various arts and manufactures; for, amongſt other advantages that will certainly ariſe from it, is the very obvious one of being able to figure that eſſential part of dreſs, linen, in a cheaper and readier way than by any yet adopted. A ſmall thin plate of iron, braſs, &c. will be found extremely uſeful, with paint, or any other ſtaining ſubſtance of a glutinous and drying nature; and an advantage with regard to time, and other important conſiderations, will undoubtedly ariſe from its uſe.

I am, &c.

S. TOPLIS.

XVI. *Continuation of Sir* BENJAMIN THOMPSON'S *Experiments upon Heat.*

(FROM P. 37.)

HAVING a watch at my ear which beat half-ſeconds, (which I counted,) I noted the time of the paſſage of the mercury over the diviſions of the thermometer; marking 70°, and every tenth degree from it, deſcending, to 10° of the ſcale. I continued the cooling to 0°, or the temperature of the ice and water, in very few inſtances, as this took up much time, and was attended with no particular advantage; the determination of the times taken up in cooling 60 degrees of Reaumur's ſcale; that is to ſay, from 70° to 10°, being quite ſufficient to aſcertain the conducting power of any body whatever.

During the time of cooling in ice and water, the thermometer was conſtantly moved about in this mixture from one place to another; and there

was

was always ſo much pounded ice mixed with the water, that the ice appeared above the ſurface of the water; the veſſel, which was a large earthen jar, being firſt quite filled with pounded ice, and the water being afterwards poured upon it, and freſh quantities of pounded ice being added as the occaſion required.

Having deſcribed the apparatus made uſe of in theſe experiments, and the manner of performing the different operations, I ſhall now proceed to give an account of the experiments themſelves.

My firſt attempt was to diſcover the relative conducting powers of ſuch ſubſtances as are commonly made uſe of for clothing; accordingly having procured a quantity of *raw ſilk*, as ſpun by the worm, *ſheep's wool*, *cotton wool*, *linen* in the form of the fineſt lint, being the ſcrapings of very fine Iriſh linen, the fineſt part of the *fur of the beaver*, ſeparated from the ſkin, and from the long hair, the fineſt part of the *fur of a white Ruſſian hare*, and *Eider down*, I introduced ſucceſſively 16 grains in weight of each of theſe ſubſtances into the globe of the paſſage-thermometer, and placing it carefully and equally round the bulb of the

the thermometer, I heated the thermometer in boiling-water, as before deſcribed, and taking it out of the boiling water, plunged it into pounded ice and water, and obſerved the times of cooling.

But as the interſtices of theſe bodies, thus placed in the globe, were filled with air, I firſt made the experiment with air alone, and took the reſult of that experiment, as a ſtandard by which to compare all the others; the reſults of three experiments with air were as follows:

The bulb of the Thermometer ſurrounded by air.				
Heat loſt.	Exp. No. 1. Time elapſed.	Exp. No. 2. Time elapſed.	Heat acquired.	Exp. No. 3. Time elapſed.
70°	—	—	10°	—
60°	38″	38″	20°	39″
50°	46	46	30°	43
40°	59	59	40°	53
30°	80	79	50°	67
20°	122	122	60°	96
10°	231	230	70°	175
Total times	576	574	—	473

The

The following table shews the results of the experiments, with the various substances therein mentioned :

Heat lost.	Air.	Raw Silk, 16 grs.	Sheep's Wool, 16 grs.	Cotton Wool, 16 grs.	Fine Lint, 16 grs.	Beaver's Fur, 16 grs.	Hare's Fur, 16 grs.	Eider Down 16 grs.
	Exp. 1.	Exp. 4.	Exp. 5.	Exp. 6.	Exp. 7.	Exp. 8.	Exp. 9.	Exp. 10
70°	—"	—"	—"	—"	—"	—"	—"	—"
60°	38	94	79	83	80	99	97	98
50°	46	110	95	95	93	116	117	116
40°	59	133	118	117	115	153	144	146
30°	80	185	162	152	150	185	193	192
20°	122	273	238	221	218	265	270	268
10°	231	489	426	378	376	478	494	485
Total Times.	576	1284	1118	1046	1032	1296	1315	1305

Now the *warmth* of a body, or its power to confine heat, being as its power of resisting the passage of heat through it, (which I shall call its *non-conducting power,*) and the time taken up by any body in cooling, which is surrounded by any medium through which the heat is obliged to pass, being, *cæteris paribus*, as the resistance which the medium opposes to the passage of the heat, it

appears that the *warmth* of the bodies mentioned in the foregoing table are as the times of cooling; the *conducting powers* being inverſely as thoſe times, as I have formerly ſhewn.

From the reſults of the foregoing experiments it appears, that of the ſeven different ſubſtances made uſe of, hare's fur and eider down were the warmeſt; after theſe came beaver's fur, raw ſilk, ſheep's wool, cotton wool, and laſtly, lint, or the ſcrapings of fine linen; but I acknowledge that the differences in the warmth of theſe ſubſtances were much leſs than I expected to have found them.

Suſpecting that this might ariſe from the volumes or ſolid contents of the ſubſtances being different, (though their weights were the ſame,) ariſing from the difference of their ſpecific gravities; and, as it was not eaſy to determine the ſpecific gravities of theſe ſubſtances with accuracy, in order to ſee how far any known difference in the volume or quantity of the ſame ſubſtance, confined always in the ſame ſpace, would add to, or diminiſh, the time of cooling, or the apparent warmth of the covering, I made the three following experiments.

In

In the firſt, the bulb of the thermometer was ſurrounded by 16 grains of eider down; in the ſecond by 32 grains; and in the third by 64 grains; and in all theſe experiments the ſubſtance was made to occupy exactly the ſame ſpace, *viz.* the whole internal capacity of the glaſs globe, in the centre of which the bulb of the thermometer was placed; conſequently the thickneſs of the covering of the thermometer remained the ſame, while its denſity was varied in proportion to the numbers 1, 2, and 4.

The reſults of theſe experiments were as follows:

The bulb of the Thermometer being ſurrounded by eider down.			
Heat loſt.	16 Grains.	32 Grains.	64 Grains.
	Exp. 11.	Exp. 12.	Exp. 13.
70°	—	—	—
60°	97″	111″	112″
50°	117	128	130
40°	145	157	165
30°	192	207	224
20°	267	304	326
10°	486	565	658
Total Times.	1304	1172	1615

Without ſtopping at preſent to draw any particular concluſion from the reſults of theſe experiments, I ſhall proceed to give an account of ſome others, which will afford us a little farther inſight into the nature of ſome of the circumſtances upon which the warmth of covering depends.

Finding, by the laſt experiments, that the denſity of the covering added ſo conſiderably to the warmth of it, its thickneſs remaining the ſame, I was now deſirous of diſcovering how far the internal ſtructure of it contributed to render it more or leſs pervious to heat, its thickneſs and quantity of matter remaining the ſame. By internal ſtructure, I mean the diſpoſition of the parts of the ſubſtance which forms the covering; thus they may be extremely divided, or very fine, as raw ſilk as ſpun by the worms, and they may be equally diſtributed through the whole ſpace they occupy; or they may be coarſer, or in larger maſſes, with larger interſtices, as the ravelings of cloth, or cuttings of thread.

If heat paſſed *through* the ſubſtances made uſe of for covering, and if the warmth of the covering depended ſolely upon the difficulty which the heat

heat meets with in its paſſage through the ſubſtances, or *ſolid parts*, of which they are compoſed, in that caſe, the warmth of covering would be always, *cæteris paribus*, as the quantity of materials of which it is compoſed; but, that this is not the caſe, the following, as well as the foregoing experiments clearly evince.

Having, in the experiment No. 4, aſcertained the warmth of 16 grains of raw ſilk, I now repeated the experiment with the ſame quantity, or weight, of the ravelings of white taffety, and afterwards with a like quantity of common ſewing-ſilk, cut into lengths of about two inches.

The following table ſhews the reſults of theſe three experiments,

Heat loſt.	Raw Silk 16 grs.	Ravelings of Taffety 16 grs.	Sewing-ſilk cut into lengths 16 grs.
	Exp. 4.	Exp. 14.	Exp. 15.
70°	—	—	—
60°	94″	90″	67″
50°	110	106	79
40°	133	128	99
30°	185	172	135
20°	273	246	195
10°	489	427	342
Total Times.	1284	1169	917

Here, notwithſtanding that the quantities of ſilk were the ſame in the three experiments, and though in each of them it was made to occupy the ſame ſpace, yet the warmth of the coverings which were formed was very different, owing to the different diſpoſition of the material.

The raw ſilk was very fine, and was very equally diſtributed through the ſpace it occupied, and it formed a warm covering.

The ravelings of taffety were alſo fine, but not ſo fine as the raw ſilk, and of courſe the interſtices between its threads were greater, and it was leſs warm; but the cuttings of ſewing-ſilk were very coarſe, and conſequently it was very unequally diſtributed in the ſpace in which it was confined; and it made a very bad covering for confining heat.

It is clear, from the reſults of the five laſt experiments, that the air which occupies the interſtices of bodies, made uſe of for covering, acts a very important part in the operation of confining heat; yet I ſhall poſtpone the examination of that circumſtance till I ſhall have given an account of ſeveral other experiments, which, I think,

think, will throw ſtill more light upon that ſubject.

But, before I go any farther, I will give an account of three experiments which I made, or rather the ſame experiment which I repeated three times the ſame day, in order to ſee how far experiments, made according to the method here deſcribed, may be depended on as being regular in their reſults.

The glaſs globe of the paſſage-thermometer being filled with 16 grains of cotton-wool, the inſtrument was heated and cooled three times ſucceſſively, when the times of cooling were obſerved as follows:

Heat loſt.	Exp. 16.	Exp. 17.	Exp. 18.
70°	—	—	—
60°	82″	84″	82″
50°	96	95	95
40°	118	117	116
30°	152	153	151
20°	221	221	220
10°	380	377	377
Total Times.	1049	1047	1042

The

The difference of the times of cooling, in theſe three experiments, was extremely ſmall; but, regular as theſe experiments appear to have been in their reſults, they were not more ſo than the other experiments made in the ſame way; many of which were repeated two or three times, though, for the ſake of brevity, I have put them down as ſingle experiments.

But to proceed in the account of my inveſtigations relative to the cauſes of the warmth of warm clothing: having found that the fineneſs and equal diſtribution of a body or ſubſtance, made uſe of to form a covering to confine heat, contributes ſo much to the warmth of the covering, I was deſirous in the next place to ſee the effect of condenſing the covering, its quantity of matter remaining the ſame, but its thickneſs being diminiſhed in proportion to the increaſe of its denſity.

The experiment I made for this purpoſe was as follows: I took 16 grains of common ſewing-ſilk, neither very fine nor very coarſe, and winding it about the bulb of the thermometer in ſuch a manner that it entirely covered it, and was as nearly as poſſible of the ſame thickneſs in every part, I

replaced

replaced the thermometer in its cylinder and globe, and heating it in boiling water, cooled it in ice and water, as in the foregoing experiments. The results of the experiment were as may be seen in the following table; and, in order that it may be compared with those made with the same quantity of silk differently disposed of, I have placed those experiments by the side of it.

Heat lost.	Raw Silk 16 grs.	Fine ravelings of Taffety 16 grs.	Sewing-silk cut into lengths 16 grs.	Sewing-silk 16 grs. wound round the bulb of the Thermometer.
	Exp. 4.	Exp. 14.	Exp. 15.	Exp. 19.
70°	—	—	—	—
60°	94″	90″	67″	46″
50°	110	106	79	62
40°	133	128	99	85
30°	185	172	135	121
20°	273	246	195	191
10°	489	427	342	399
Total Times.	1284	1169	917	904

It is not a little remarkable that, though the covering formed of sewing-silk wound round the bulb of the thermometer, in the 19th Experiment, appeared

appeared to have ſo little power of confining the heat when the inſtrument was very hot, or when it was firſt plunged into the ice and water, yet afterwards, when the heat of the thermometer approached much nearer to that of the ſurrounding medium, its power of confining the heat which remained in the bulb of the thermometer appeared to be even greater than that of the ſilk in the Experiment No. 15; the time of cooling from 20° to 10° being in the one 399″, and in the other 342″. The ſame appearance was obſerved in the following experiments, in which the bulb of the thermometer was ſurrounded by threads of *wool*, of *cotton*, and of *linen*, or *flax*, wound round it, in the like manner as the ſewing-ſilk was wound round it in the laſt experiment.

The following table ſhews the reſults of theſe experiments, with the threads of various kinds; and, that they may the more eaſily be compared with thoſe made with the ſame quantity of the ſame ſubſtances in a different form, I have placed the accounts of theſe experiments by the ſide of each other. I have alſo added the account of an experiment, in which 16 grains of fine linen cloth were

were wrapped round the bulb of the thermometer, going round it nine times, and being bound together at the top and bottom of it, ſo as completely to cover it.

Heat loſt.		70°	60°	50°	40°	30°	20°	10°	Total Times.
Sheep's Wool 16 grs. ſurrounding the bulb of the Thermometer.	Exp. 5.	—	79″	95	118	162	238	426	1118
Woollen Thread 16 grs. wound round the bulb of the Thermometer.	Exp. 20.	—	46″	63	89	126	200	410	934
Cotton Wool 16 grs. ſurrounding the bulb of the Thermometer.	Exp. 6.	—	83″	95	117	152	221	378	1046
Cotton Thread 16 grs. wound round the bulb of the Thermometer.	Exp. 21.	—	45″	60	83	115	179	370	852
Lint 16 grs. ſurrounding the bulb of the Thermometer.	Exp. 7.	—	80″	93	115	150	218	376	1032
Linen Thread 16 grs. wound round the bulb of the Thermometer.	Exp. 22.	—	46″	62	83	117	180	385	873
Linen Cloth 16 grs. wrapped round the bulb of the Thermometer.	Exp. 23.	—	42″	56	74	108	168	338	783

 That

That thread wound light round the bulb of the thermometer ſhould form a covering leſs warm than the ſame quantity of wool, or other raw materials of which the thread is made, ſurrounding the bulb of the thermometer in a more looſe manner, and conſequently occupying a greater ſpace, is no more than what I expected, from the idea I had formed of the cauſes of the warmth of covering; but, I confeſs, I was much ſurpriſed to find that there is ſo great a difference in the relative warmth of theſe two coverings, when they are employed to confine great degrees of heat, and when the heat they confine is much leſs in proportion to the temperature of the ſurrounding medium. This difference was very remarkable; in the experiment with ſheeps wool, and with woollen thread, the warmth of the covering, formed of 16 grains of the former, was to that formed of 16 grains of the latter, when the bulb of the thermometer was heated to 70°, and cooled to 60°, as 79 to 46, (the ſurrounding medium being at 0°,) but afterwards, when the thermometer had fallen from 20° to 10° of heat, the warmth of the wool was to that of the woollen thread

only

only as 426 to 410; and, in the experiments with lint, and with linen thread, when the heat was much abated, the covering of the thread appeared to be even warmer than that of the lint, though, in the beginning of the experiments, when the heat was much greater, the lint was warmer than the thread, in the proportion of 80 to 46.

Hence it ſhould ſeem that a covering may, under certain circumſtances, be very good for confining ſmall degrees of warmth, which would be but very indifferent when made uſe of for confining a more intenſe heat, and *vice verſa*. This, I believe, is a new fact; and I think the knowledge of it may lead to farther diſcoveries relative to the cauſes of the warmth of coverings, or the manner in which heat makes its paſſage through them. But I forbear to enlarge upon this ſubject, till I ſhall have given an account of ſeveral other experiments, which, I think, throw more light upon it, and which will conſequently render the inveſtigation eaſier and more ſatiſfactory.

With a view to determine how far the power which certain bodies appear to poſſeſs of confining heat, when made uſe of as covering, depends upon the natures of thoſe bodies, conſidered as chymical ſubſtances, or upon the chymical principles of which they are compoſed, I made the following experiments.

As charcoal is ſuppoſed to be compoſed almoſt entirely of phlogiſton, I thought that, if that principle was the cauſe either of the conducting power, or the non-conducting power, of the bodies which contain it, I ſhould diſcover it by making the experiment with charcoal, as I had done with various other bodies. Accordingly, having filled the globe of the paſſage-thermometer with 176 grains of that ſubſtance in very fine powder, (it having been pounded in a mortar, and ſifted in a fine ſieve,) the bulb of the thermometer being ſurrounded by this powder, the inſtrument was heated in boiling-water, and being afterwards plunged into a mixture of pounded ice and water, the times of cooling were obſerved, as mentioned in the following table. I afterwards repeated the experiment with lamp-black, and with

very

very pure and very dry wood aſhes; the reſults of which experiments were as under-mentioned:

The bulb of the Thermometer ſurrounded by				
Heat loſt.	176 grs. of fine powder of Charcoal.	176 grs. of fine powder of Charcoal.	195 grs. of Lamp-black.	307 grs. of pure dry wood-aſhes.
	Exp. 24.	Exp. 25.	Exp. 26.	Exp. 27.
70°	—	—	—	—
60°	79″	91″	124″	96″
50°	95	91	118	92
40°	100	109	134	107
30°	139	133	164	136
20°	196	192	237	185
10°	331	321	394	311
Total times.	940	937	1171	927

The experiment No. 25 was ſimply a repetition of that numbered 24, and was made immediately after it; but, in moving the thermometer about in the former experiment, the powder of charcoal which filled the globe was ſhaken a little together, and to this circumſtance I attribute the difference in the reſults of the two experiments.

In

In the experiments with lamp-black, and with wood-aſhes, the times taken up in cooling from 70° to 60° were greater than thoſe employed in cooling from 60° to 50°; this moſt probably aroſe from the conſiderable quantity of heat contained by theſe ſubſtances, which was firſt to be diſpoſed of, before they could receive, and communicate to the ſurrounding medium, that which was contained by the bulb of the thermometer.

The next experiment I made was with *ſemen lycopodii*, commonly called witch-meal, a ſubſtance which poſſeſſes very extraordinary properties. It is almoſt impoſſible to wet it; a quantity of it ſtrewed upon the ſurface of a baſin of water, not only ſwims upon the water without being wet, but it prevents other bodies from being wet which are plunged into the water through it; ſo that a piece of money, or other ſolid body, may be taken from the bottom of the baſin by the naked hand, without wetting the hand, which is one of the tricks commonly ſhewn by the jugglers in the country; this meal covers the hand, and, deſcending along with it to the bottom of the baſin, de-

fends

fends it from the water. This ſubſtance has the appearance of an exceeding fine, light, and very movable, yellow powder, and it is very inflammable; ſo much ſo, that being blown out of a quill into the flame of a candle, it flaſhes like gunpowder, and it is made uſe of in this manner in our theatres for imitating lightning.

Conceiving that there muſt be a ſtrong attraction between this ſubſtance and air, and ſuſpecting, from ſome circumſtances attending ſome of the foregoing experiments, that the warmth of a covering depends not merely upon the fineneſs of the ſubſtance of which the covering is formed, and the diſpoſition of its parts, but that it ariſes in ſome meaſure from a certain attraction between the ſubſtance and the air which fills its interſtices. I thought that an experiment with *ſemen lycopodii* might poſſibly throw ſome light upon this matter; and in this opinion I was not altogether miſtaken, as will appear by the reſults of the three following experiments.

The bulb of the Thermometer surrounded by 256 grains of *semen lycopodii.*				
Heat lost.	Cooled. Exp. 28.	Cooled. Exp. 29	Heat acquired.	Heated. Exp. 30.
70°	—	—	0°	—
60°	146″	157″	10°	230″
50°	162	160	20°	68
40°	175	170	30°	63
30°	209	203	40°	76
20°	284	288	50°	121
10°	502	515	60°	316
—	—	—	70°	1585
Total times.	1478	1491	—	2459

TO BE CONCLUDED IN OUR NEXT.

XVII.

XVII. *Defcription and Ufe of a Machine for clearing Land from Stones, and for fifting Sand or Gravel;* *invented by* PETER FRANCIS PONTI.

WITH A PLATE.

From the TRANSACTIONS of the PATRIOTIC SOCIETY of MILAN.

A Premium of Sixteen *fcudi*, and a Silver Medal, were given to the Inventor of this Machine.

WRITERS on agriculture have difputed whether it is proper to clear land from ftones, or not: fome affert that thofe ftones which are of calcareous nature, if not very large, or very numerous, are advantageous both to vines and to corn; as they ferve to keep the land loofe and dry, and to defend it, in fome meafure, from the burning rays of the fun; while, at the fame time, they

keep it warm, becaufe they retain the heat they receive longer than the earth itfelf can do.

It is however certain that, notwithftanding thefe advantages, every farmer diligently endeavours to clear his ground from ftones; for, other circumftances being equal, the ground is found to be lefs fruitful in proportion as it is more ftony. So well affured of the truth of this maxim are the farmers near the mountain of Brianza, that they are always willing to pay a greater rent to their landlords, provided the land is delivered to them free from ftones.

To clear it, however, either by picking up the ftones and throwing them on one fide, as fome perfons have advifed, or by fifting the earth through a fieve of wood or iron, as is ufually done with refpect to garden-mould, is fo troublefome and expenfive an operation, as to be againft all rules of œconomy, and therefore incapable of being practifed on a large fcale.

Thefe confiderations induced Peter Francis Ponti, an able and induftrious fmith, to conftruct a machine which, on account of its fimplicity and

its

its ſmall price, may be advantageouſly and œconomically made uſe of by thoſe who wiſh to clear their land from ſtones; it has this farther advantage, that, by its means, the ſtones may be buried where the roots of annual plants do not reach; and, in that ſituation, they will be of advantage to the roots of trees, which do not grow ſo well amidſt the ſtagnant and putrid humours of tenacious ſoils. With this machine alſo, ſand or gravel of any ſize may be ſifted, as will be explained hereafter.

Description of the Machine.

(See Plate VIII.)

Upon four feet of wood *a a a a* is ſupported a beam *c*; to the ends of this beam are fixed two pieces of wood *d* and *g*, in which is placed the iron axis *e*. This axis, that the weight of the baſket or recipient *i m h i m h* may not raiſe it up, is retained, at *d*, by a band of iron, which is faſtened over it by means of a hook *l*. To the feet are fixed two croſs pieces *b b*; theſe are placed within

the feet, that they may be nearer each other; as they ſerve not only to ſtrengthen the machine, and keep it ſteady, but alſo to tranſport it from place to place; for which purpoſe they are made to project in the form of handles, by means of which two men may carry the machine about with great eaſe. *k* is the iron axis continued to form the handle of the baſket; when this handle is turned round, the axis and the baſket turn with it; the axis fixed to the bottom of the baſket by a croſs of iron proceeding from it; or it may be made to paſs through the baſket, and be fixed on the inſide of it ſo firmly as to carry it round.

This baſket has a thick bottom of wood, to which are faſtened, by nails, (both on the flat part and on the edge,) the iron bars of which the ſaid baſket is formed. Theſe make an obtuſe angle with the bottom, in ſuch a manner that the diameter of the outer periphery *b b* is double that of the bottom; the length of the rods is equal to that of the diameter *b, b*, and they are, at that part, ſtrongly fixed to an iron hoop.

The

The diameter of the baſket is not quite two Paris feet, and all the other parts are in proportion to that, as appears in the figure. The machine however may be made either larger or ſmaller.

It muſt be evident that, if the bars were of equal width from one end to the other, the ſpaces between them would grow wide too ſuddenly; to prevent this, the bars are made ſquare, or rather round, towards *i i*, and they are beat out, ſo as to be gradually wider, as they approach *h h*; by which the ſpaces between the bars do not increaſe in proportion to the width of the baſket.

If the bars made uſe of ſhould be thought too weak, they may be ſtrengthened by fixing another hoop of iron to them at *m m*.

If, with this machine, it is intended not only to clear land from ſtones, but alſo to ſift ſand or gravel, a ſort of ſieve, for that purpoſe, may be formed round it with iron wire; the interſtices of which may be made larger or ſmaller, according to the ſand or gravel to be ſifted.

Manner

Manner of uſing the Machine.

When the machine is to be uſed for clearing a field from ſtones, it muſt be placed at one end of the field; in the front of it are to ſtand two men, who, with ſpades or ſhovels, throw the earth, &c. which they dig up, (to whatever depth may be thought proper,) into the baſket, which is turned round by another man, or by a boy; for, that part of the operation is by no means laborious. The earth and ſtones ſtrike againſt the wooden bottom, and fall upon the bars; the rotatory motion of the baſket turns round the earth and ſtones, which, from the inclination or divergence of the bars, deſcribe a ſpiral line. In the mean time the earth, ſand, and very ſmall ſtones, fall directly under the baſket, through the ſpaces between the bars; and the larger ſtones, or other bodies which are too big to paſs between the bars, are thrown to a certain diſtance from the baſket, into a hollow trench, made for the purpoſe of receiving them; when the men are got ſo far from the machine that it

becomes

becomes troubleſome to throw the earth, &c. into the baſket, the machine muſt be moved forward, (which, as is before ſaid, may be eaſily done by the two croſs pieces *b b*,) and placed ſo that the baſket may be exactly over the ſtones already ſeparated, they having been previouſly ſpread out in an even manner. The work being then continued, the earth which falls through the bars covers the ſtones, and, as it collects in a heap, it muſt be ſpread, and laid level.

Hence, beſides the two men who throw in the earth, &c. with ſpades or ſhovels, it is proper to engage a third, to ſpread out the ſtones and the earth: this is more particularly neceſſary if the ground is ſo hard as to require much breaking before it is thrown into the baſket; or if, on account of its being too wet, it unites into large maſſes.

The moſt convenient time for this operation is when the ground is neither exceſſively dry, for in that caſe the duſt is very troubleſome, nor exceſſively wet, because then the earth is thrown out of the mouth of the baſket with the ſtones, and is alſo

apt to ſtick to the bottom, and in the ſpaces between the bars, which of courſe renders the machine inconvenient to uſe, and leſs fit for its deſtined purpoſe.

To a *Conſtant Reader*, who wiſhes for information reſpecting the cheapeſt and moſt expeditious method of taking away the colour of rape oil, linſeed oil, &c. we can only ſay, that, if any of our correſpondents will favour us with information on the ſubject, we ſhall be very happy to publiſh it. It was ſuggeſted ſeveral years ago, by Dr. Struve, that oils might be deprived of their colour, and alſo of any bad ſmell, by agitating them in water mixed with ſand; uſing a large quantity of water and changing it for freſh, when it becomes turbid, and charged with mucilage. Dr. Struve ſays he tried this method on a ſmall quantity of oil in a phial, and found it to ſucceed; we have, however, been informed that it was tried here without ſucceſs.

In the year 1792 a patent was taken out for *depurating and improving animal oil*, by agitating it in water impregnated either with an acid or an alkali; the ſpecification of which our correſpondent will find in our fourth number.

THE TANJORE MAHARAJA SERFOGI'S SARASW
AL.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XXI.

XVIII. *Specification of the Patent granted to Mr.* John Longbotham, *of Chorley, in the County of Lancaſter, Engineer, for his Invention of a Plan or Method of ſupplying Canals, or any other Cuts, Ponds, or Sluices, wanting the ſame, with Water.*

Dated July 28, 1792.

To all to whom theſe preſents ſhall come, &c. Now know ye, that, in purſuance of, and in compliance with, the ſaid proviſo, I the ſaid John Longbotham do hereby declare, that the nature of my ſaid invention, and the manner in which

the ſame is to be performed, is as herein after deſcribed and ſet forth; that is to ſay, the ſaid invention is calculated to ſupply canals, ponds, ſluices, towns, or any other place, wanting the ſame, with water, by making reſervoirs, of any dimenſions, upon high and mooriſh grounds, or any other places ſuitable for the purpoſe; which reſervoirs are to be ſupplied with water in the following manner; that is to ſay, from calculations and experiments I found, that in the courſe of twelve months there falls upon the ſurface of a ſuperficial foot of land 3 feet 33 parts, cubical feet, of rain, excluſive of the exhalation; ſo that, upon the ſurface of one ſtatute-acre there falls to the amount of 145054,80 cubic feet of water, or thereabouts. And I can convey water falling upon 3500 ſtatute-acres, more or leſs, into reſervoirs in the following manner; that is to ſay, I make a reſervoir of 100 ſtatute-acres, more or leſs, in the moſt eligible ſituation; from which reſervoir, open drains or ſluices are made, in the moſt proper places for receiving water running from the ſurface of the grounds in rainy weather, including the

the ſpace of 3500 ſtatute-acres, more or leſs, and by or through which drains or ſluices all the water that falls in rainy weather, from the ſaid ſurface, may be conveyed into ſuch reſervoir; which, according to the calculation, will be nearly equal to 507691800 cubic feet *per annum* brought into the reſervoir, except in loſs of water in ſoakage, which cannot be aſcertained in the compaſs of the ſaid ſurface: this may be done without prejudice to any river or water mills. The area of a reſervoir of 100 ſtatute-acres is 4356000 ſuperficial feet, and the average depth 9 feet 75 parts, but, allowing 9 inches for exhalation *per annum*, the 75 parts of a foot are not included, ſo that 4356000 ſuperficial feet, the area, multiplied by 9 feet, the depth, gives 39204000, the quantity of cubic feet of water contained in the reſervoir of reſerved water. In the courſe of twelve months, as before ſtated, there comes a ſupply of water, except as before, into the reſervoir, of 507691800 cubic feet; which, divided by 365 days, gives 1390936,260, the number of cubical feet that runs into the reſervoir daily, upon an average; which quantity

may be let out regularly every twenty-four hours, to ſupply canals, cuts, ſluices, ponds, towns, mills, or any other places. And by which means the 39204000 cubic feet, the reſerve-water in the reſervoir, will not be affected, but there will ſtill remain the ſame quantity in the reſervoir, except for the ſpace of ninety-two days in the year, which I calculate for dry ſeaſons when there is no rain; and, during ſuch time, 426134,40 cubic feet, or thereabouts, of water may be let out daily, for the ſupply of ſuch canals, cuts, ponds, ſluices, mills, towns, or other places wanting the ſame, or in greater or leſs quantities, as occaſion may require. It may be found neceſſary to make ſome other reſervoirs, to communicate with the before mentioned one, containing nearly the ſame quantity of water, to be occaſionally let into it in dry ſeaſons. Alſo all ſituations perhaps will not admit of taking in ſo large a ſurface, neither of making a reſervoir of 100 ſtatute-acres, conveniently; when this is the caſe, I proceed upon a ſmaller ſcale of ſurface, and by making three or four ſmaller reſervoirs, communicating one with another,

ther, with drains, as the nature of the lands and ſituations will allow of, for the ſupplying of canals, cuts, ponds, ſluices, mills, towns, &c. containing nearly the ſame quantity of water as before ſtated. I now proceed to the deſcription how the water may be conducted, from ſuch reſervoir or reſervoirs, into the canals, cuts, ponds, ſluices, mills, towns, or other works which are to be ſupplied, which is as follows; in the firſt place, I make two aqueducts, of ſtone or brick with mortar, for conveying the water out of the reſervoir or reſervoirs, from the bottom, where the water falls perpendicular from its ſurface into the ſpace of a larger circle of ſtone-work, with which the openings of the aqueducts communicate; to receive the water falling perpendicular from the ſurface of them, in each of theſe aqueducts I fix a paddle or clough, at a proper place, equal to an opening of fifteen by twelve inches, which paddle or clough is raiſed by a ſcrew fixed to it, and moves upright in a piece of iron fixed acroſs at the upper part of it; upon it is a ſquare box, including a female ſcrew, in which the other moves,

which is turned round by four ſmall hand-levers, fixed to the ſquare box, which reſts upon a ſmall reſt on the croſs iron bar, which raiſes the ſcrew and paddle, or by other mechanical powers, to the following heights: with an opening of three by twelve inches, may be delivered 317952 cubic feet of water in 24 hours: with an opening of ſix by twelve inches, may be delivered 630730 cubic feet in 24 hours: with an opening of nine by twelve inches, may be delivered 927936 cubic feet of water in 24 hours: with an opening of twelve inches ſquare, may be delivered 1222560 cubic feet in twenty-fours: with an opening of twelve by fifteen inches may be delivered 1512000 cubic feet in 24 hours; or a leſs or greater quantity, in proportion to the opening and velocity, as occaſion may require, for the ſupplying canals, ponds, ſluices, towns, mills, or any other works wanting the ſame. The quantity of water required to be let out of the reſervoirs may be regularly aſcertained in the following manner; by fixing at the head of the ſcrew a pointer, and an index above it, of inches and decimal parts; and, as the

paddle

paddle is raiſed by the ſcrew fixed to it, the pointer at the end of it, ſliding upon the index, will ſhew the quantity of water diſcharged upon every diviſion of it, as ſet forth; as, at three inches high, there will run out of the reſervoir 317952 cubic feet in 24 hours; and, at ſix inches high, the pointer will ſhew at that diviſion there will run out of the reſervoir 630730 cubic feet of water in 24 hours; and ſo on, in a greater or leſs quantity, as occaſion may require, till the paddle or clough is raiſed to its greateſt height. Having ſhewn the manner of ſupplying large canals with water, and delivering ſuch ſupplies of the reſervoirs, in ſuch proportion and quantities as may be wanted; I now come to taking in leſs ſurface, and making reſervoirs and conduct-drains, as before mentioned, upon a ſmaller ſcale, for the ſupplying of leſs works, and the quantity of water of ſupply delivered out of the reſervoirs, either in the ſame manner, as before ſpecified, or in a different manner, as hereafter will be explained: that is, ſuppoſing the falls of rain upon 1200 ſtatute-acres, or a greater or leſs quantity of

ſurface,

surface, upon every superficial foot, as before stated, the falls of rain are equal to 3 feet 33 parts, cubic feet, then in 1200 statute-acres, there will be 174065760 cubic feet falls of rain in one year, and a reservoir of 50 statute acres, of the depth of 9 feet 75 parts, will contain 19602000 cubic feet, casting away the 75 decimal parts of nine inches, allowed for exhalation; and, by dividing the falls of rain upon 1200 statute-acres, which is equal to 174065760 cubic feet, or thereabouts, by 365 days, there will be 476892 cubic feet nearly for every day in the year, without affecting the water in the reservoir; and the quantity of water contained in the reservoir is equal to 19602000 cubic feet, which, divided by 92 days, gives 213166,28 cubic feet *per* day in dry seasons, for supplying canals, ponds, sluices, mills, towns, or any other places wanting the same; which is gradually let out as wanted, in the same manner as before prescribed, or differently, by iron pipes or cylinders fixed at the bottom of the reservoir, to receive the fall of the water from the surface out of the large circle of stone-work, as before

before mentioned for the ſaid purpoſe; which water alſo may be diſcharged out of the pipes or cylinder, by fixing a large braſs or copper ſtop-cock, the head of which to be moved round by a lever, or by a wheel and pinion, or by any other mechanical powers to turn the ſame; at which place I propoſe to have a circular or half-circular plate, with an index of inches and decimal parts marked upon it, with diviſions ſpecifying the neat quantity diſcharged at ſuch places *per* hour or day, as occaſion may require, for ſupplying canals, cuts, ponds, ſluices, mills, towns, &c. I now come to the method of conveying the water, after the ſame is diſcharged out of the reſervoirs before mentioned, for ſupplying canals, ponds, ſluices, mills, towns, or any other places, which, may be in want of the ſame. This may be done either by open drains, or by aqueducts, made of ſtone or brick and mortar, under ground, from one mile to fifteen miles from the running of the waters out of the reſervoirs, for ſupplying canals, ſluices, ponds, mills, towns, and other places. I have farther to add, when works of this kind

are carried into execution, as aforesaid, and set forth, that there may be a house built at the most convenient place, to secure and preserve the principal works, and for letting off the water, for a person or persons to live in to take care of them, also of discharging the water properly as prescribed and set forth, as before mentioned; also small towns, villages, and gentlemen's seats and houses, may be supplied with water, by making small reservoirs, in proportion to the quantities wanted, in proper situations, and convey the same by drains, aqueducts, iron pipes, lead, copper, or wood, to the places wanting the same, from one to fifteen miles, and secure the water by making water-houses for the purpose. In witness whereof, &c.

XIX. *Specification of the Patent granted to Mr.* ANTHONY BOURBOULON DE BONEUIL, *of Liverpool, in the County Palatine of Lancaſter; for his Invention of an Apparatus and Proceſſes for the Purpoſe of practiſing a Chymical Mode of whitening every vegetable Subſtance, ſuch as Hemp, Flax, Cotton, Wax, and other Articles, unaccompanied by the Inconveniences which have attended other Methods and Proceſſes heretofore made uſe of.*

WITH THREE PLATES.

Dated March 25, 1789.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, I the ſaid Anthony Bourboulon de Boneuil do hereby declare, that my ſaid invention is deſcribed in the plan and deſcription thereof hereunto annexed. In witneſs whereof, &c.

Previous to specifying my apparatus and processes, and to do it in such a manner as may shew their novelty as well as their utility, and thereby prevent the claim of others, I think it proper to make some observations; viz. chymistry affords many ways of improving the arts used in preparing materials for trade, but there is yet a great difference between the theory of the principles that are intimated and the efficacy of their use; experience too often proves how insufficient is the theory alone, and that it is not enough to point out the line upon which we must proceed, there needs also the art of beating the way, so that it may be pursued generally, easily, and usefully, in every respect. It is likewise known, that in chymistry the success of every theoretical discovery almost always depends upon the form of the apparatus used; and that a chymist is deemed ingenious in proportion to his skill in devising a proper apparatus, of which the choice requires no less knowledge of both physical and chemical rules.

Particular Observations. Chymistry is indebted to Messrs. Scheele and Bergman for the principle, and almost the first notions upon the marine acid

acid dephlogiſticated by manganeſe, and lately to Doctor Berthollet for other more extenſive notions; from numerous experiments he has made upon the ſame gaz, he has eſpecially aſcertained the influence of it on every vegetable ſubſtance containing phlogiſton. Doctor Berthollet has likewiſe publiſhed an apparatus for collecting the gaz, different from that uſed by Meſſrs. Scheele and Bergman; but his apparatus, deſigned in the plan here annexed, No. 1, (ſee Plate IX,) is itſelf full of inconveniences to be practiſed in a large way; on the one hand, the water, being in each decanter he uſed, oppoſes the progreſs of the gazeous air; and the efforts the air makes, according to phyſical principles, to ſurmount the reſiſtance it meets with, are ſo ſtrong, and ſo often repeated, that the veſſels are frequently broken, and the lutes deſtroyed; on the other hand, there is a frequent eſcape of the gaz from the iſſue of the decanters, which becomes dangerous, or at leaſt noxious and inſupportable, to the workmen. The object of my ſtudy and labour has been to remedy theſe inconveniences, and likewiſe to diſcover the means of

collecting the gaz mentioned in ſuch a manner as it might whiten vegetable ſubſtances in a larger way, and which ſhould be more convenient and advantageous than that till now uſed, and thus become a ſubſtitute for it. The ſucceſs has very luckily anſwered my attempts. I firſt improved the mode pointed out by the chymiſts above mentioned for collecting the gaz in water, by inventing the new apparatus deſigned in the plan here annexed, No. 2, (Plate IX,) which is grounded upon phyſical principles entirely different from theirs. Inſtead of having the water, as they do, in veſſels with ſhort necks, and lying upon the ground, I keep it in veſſels with long necks, and hung up, as appears by the plan. Farther, for the practice of this improvement and new method, I proceed as follows: I put the mixture of marine acid and mangane ſe, in a glaſs or earthen retort or bottle A, (Plan No. 2,) upon an ordinary furnace for diſtillation B. I adapt to the mouth of the retort a glaſs tube C, thruſt into a cork; I place the end of this tube under the mouth of the matraſs D, hung up with a trivet E, or otherwiſe, and in which is contained

the

the water deſtined to receive the gazeous air. The neck F of the matraſs is immerſed into a ſmall earthen pot G, which is full of water, and has a conduit H, through which the gazeous air iſſues with the water into a recipient or earthen bottle I, of the ſame capacity with the matraſs; which, as well as the bottles, may be conſtructed of any other material and form. As the neck of the matraſs may be, in this apparatus, as long as I pleaſe, I am able to have ſuch a height of column of water as is convenient; and, as the maſs of the water is hung up in equilibrium with the atmoſpheric air, and the orifice of the matraſs is introduced into the water of the ſmall earthen pot G not more than one ſixth of an inch, the elaſtic air, carrying the gazeous air, meets but with little reſiſtance; ſo that it comes eaſily to the end of the tube, where (by being naturally lighter than the water) it quickly runs to the top of the matraſs through the neck of it, after having by the way depoſed the gaz. The compreſſion of the elaſtic air, breaking the equilibrium mentioned, forces the water in the matraſs to deſcend, and thus convey with it, into the recipient I, the gaz with which it has been impregnated.

pregnated. It is to be obſerved, I uſe no lute, either for retort or matraſs; by this mode the whitening-liquor is made without any trouble, reſiſtance, nuiſance, or loſs. But this my improvement goes ſtill farther; as, whilſt I make the liquor proper to whiten the mode juſt mentioned, at the ſame time I whiten the vegetable ſubſtances by the immediate contact of the gazeous air, without uſing the interference of the water to collect it beforehand. The apparatus I have invented for that purpoſe is deſigned in the plan here annexed, No. 3, (Plate X,) and I proceed with it as follows.

The diſtillation of marine acid mixed with manganeſe is made as in the proceſs juſt mentioned, upon the furnace K, (Plan No. 3,) but, inſtead of introducing the glaſs ſyphons B, adapted to the retorts C, immediately into the necks of the matraſſes D ſo hung up as I do in the apparatus of plan No. 2, I make each of the ſyphons paſs immediately through the wall of a lodge A, (Plan No. 3,) which I ſettle between the retorts C and matraſs D, into the veſſels E, full of water; or, to prevent the wall from being ſo much open, I con-

I conduct all the glaſs ſyphons, and immerſe them in the veſſel E, full of water (Plan No. 4, Plate XI.) under a lamp L, of glaſs or earth, from which the gaz goes into the lodge through a ſingle tube M, adapted under the ſame lamp in the veſſel E, and croſſing the wall of the lodge. With this apparatus the gaz, going with the elaſtic air from the retorts or bottles into the lodge, is applied inceſſantly to the phlogiſton of the incloſed goods, and leaves them whitened. In order to give the ſuperabundant elaſtic air the iſſue it requires, and to make the liquor proper to whiten, I have near the top of the lodge A (Plan No. 3.) ſome holes G, to which are adapted the large ſyphons F, which come down into the pots H, in which the necks of the matraſſes D are immerſed. The elaſtic air, thus going through the ſyphons F, deſcends to the necks of the matraſſes D, in which it depoſes the gaz it carries, as it happens in the apparatus of plan No. 2. I ſhall obſerve by the way: Firſt, that to prevent or remedy the inconvenience of the marine acid being introduced into the liquor, or the lodge, I uſe the different

ways known in chymiſtry, as well as to make the lodge free from the gazeous air as to prepare it for every other operation. Secondly, the lodge may be made of many forms and materials, it wants only to be kept very cloſe to avoid the eſcape of the gazeous air. Thirdly, the goods to be whitened in the lodge are hung up, ſo that the gazeous air may eaſily penetrate them. Fourthly, the manner of whitening the goods in the liquor impregnated with the gazeous air is, by ſinking them into that liquor, and there ſtirring them as long as is deemed neceſſary, according to the quality of ſuch goods. Such are the new apparatus and proceſſes in the enjoyment of which I claim to be ſecured under the patent, as being of my own invention, and hitherto unknown and unpractiſed in this kingdom; my invention conſiſting not only in the novelty of the apparatus, but alſo in the phyſical and chymical principles of the two proceſſes to which they are applied.

EXPLA-

EXPLANATION OF THE FIGURES.

(See Plates IX, X, and XI.)

Plate IX. Apparatus for a liquor proper to whiten the vegetable materials.

No. 1. M. Berthollet's apparatus.

No. 2. A A. Retorts or bottles.

B. Furnace.

C C. Glaſs tubes.

D D. Matraſſes.

E E. Trivets or ſtands.

F F. Necks of the matraſſes.

G G. Earthen pots.

H H. Conduits of the pots.

I I. Earthen bottles.

Plate X. No. 3. Apparatus for whitening the vegetable materials during the diſtillation itſelf, from which at once ariſes the whitening liquor.

A. The lodge.

B B. Glaſs ſyphons.

C C. Retorts.

D D. Matraſſes.

E E. Veſſels full of water.

F F. Syphons.

G G. Communication of the ſquare ſyphons with the lodge.

H H. Earthen pots.

I. The door of the lodge.

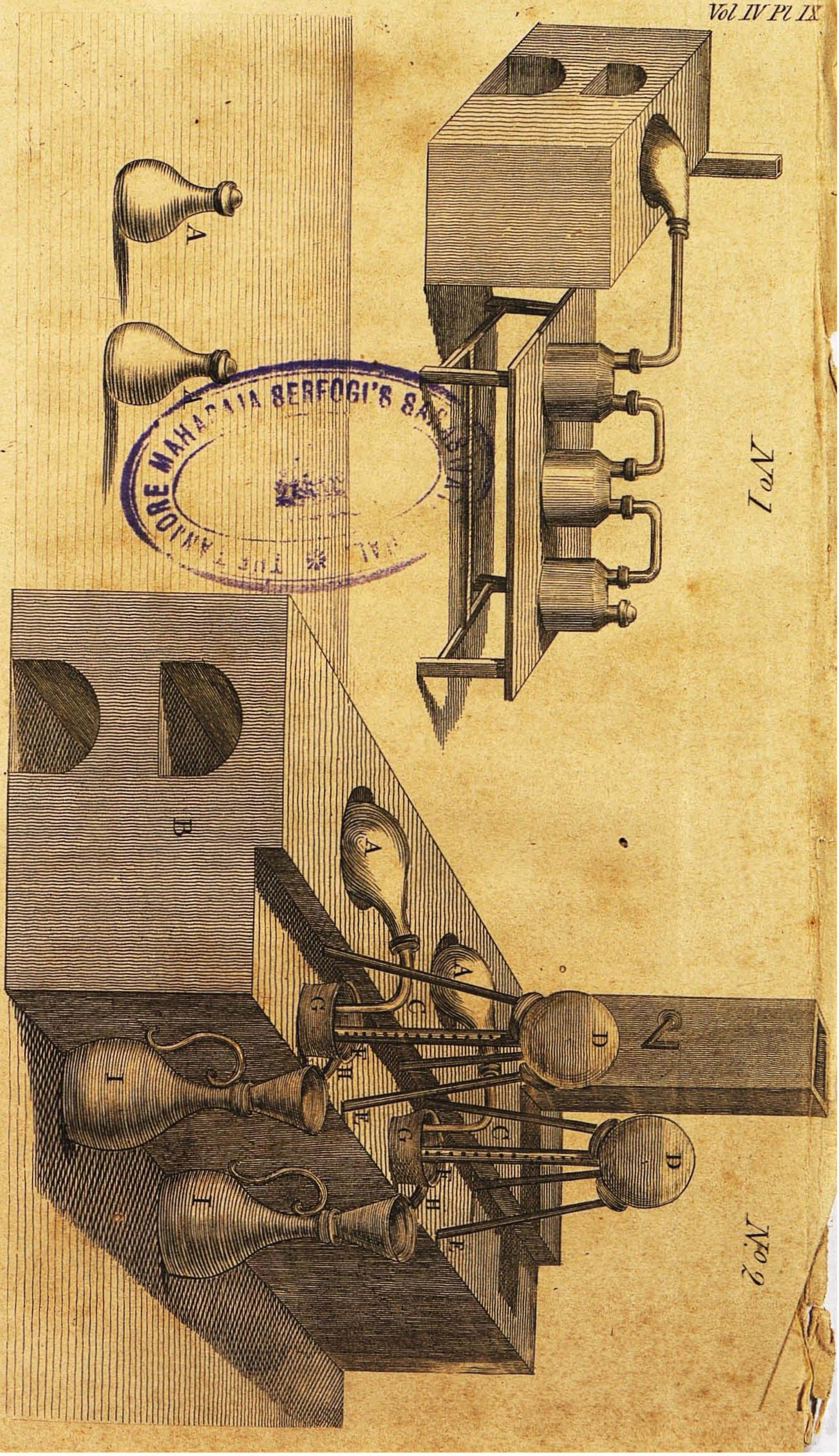
K. The furnace.

Plate XI. No. 4. A A. The bottles that may be uſed inſtead of the retorts repreſented in No. 3.

E. The veſſel full of water, into which the long glaſs ſyphons adapted to the bottles are immerſed.

L. The lamp under which the ſyphons are joined in the veſſel E.

M. The tube through which the gaz goes into the lodge.



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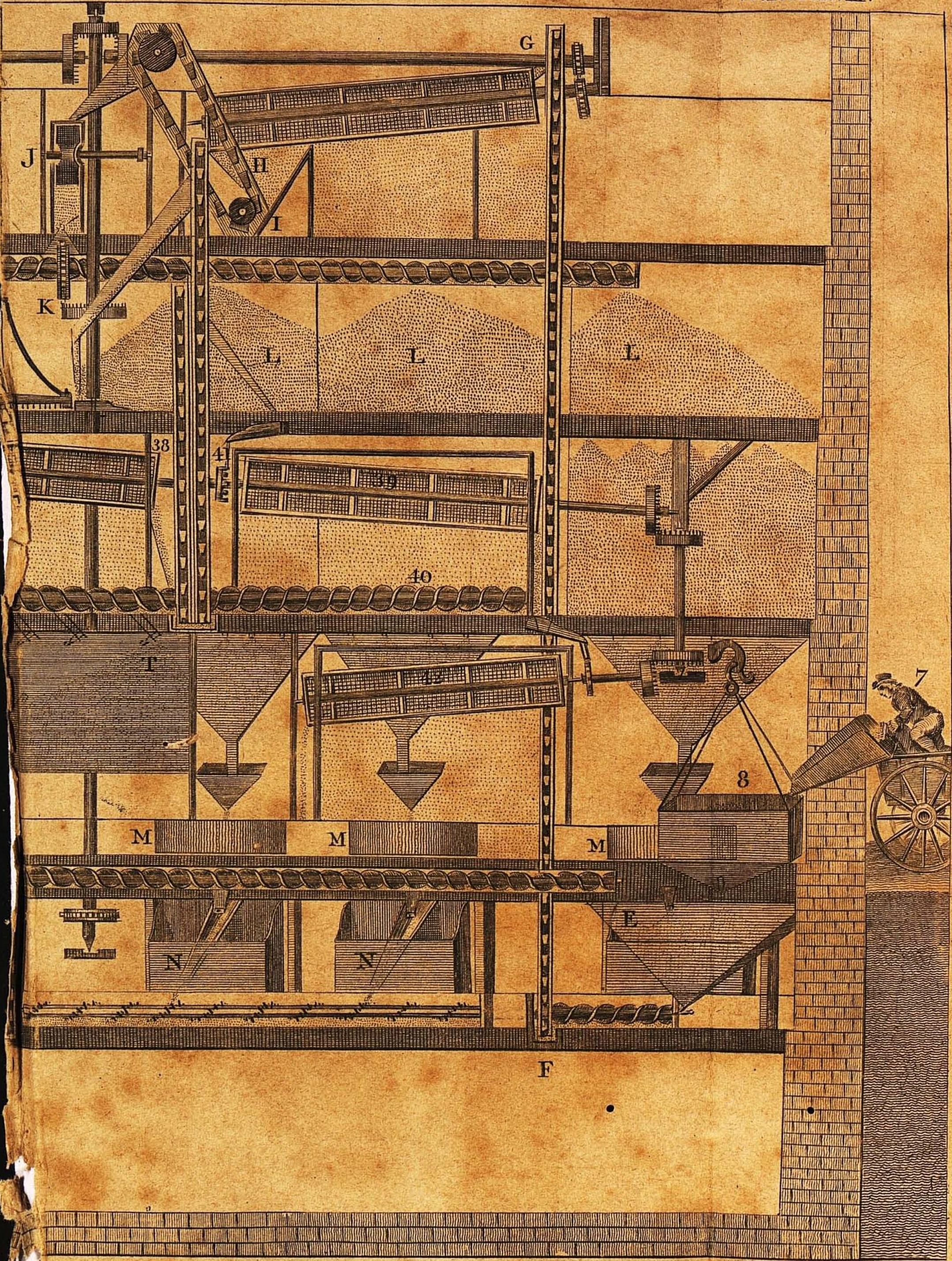
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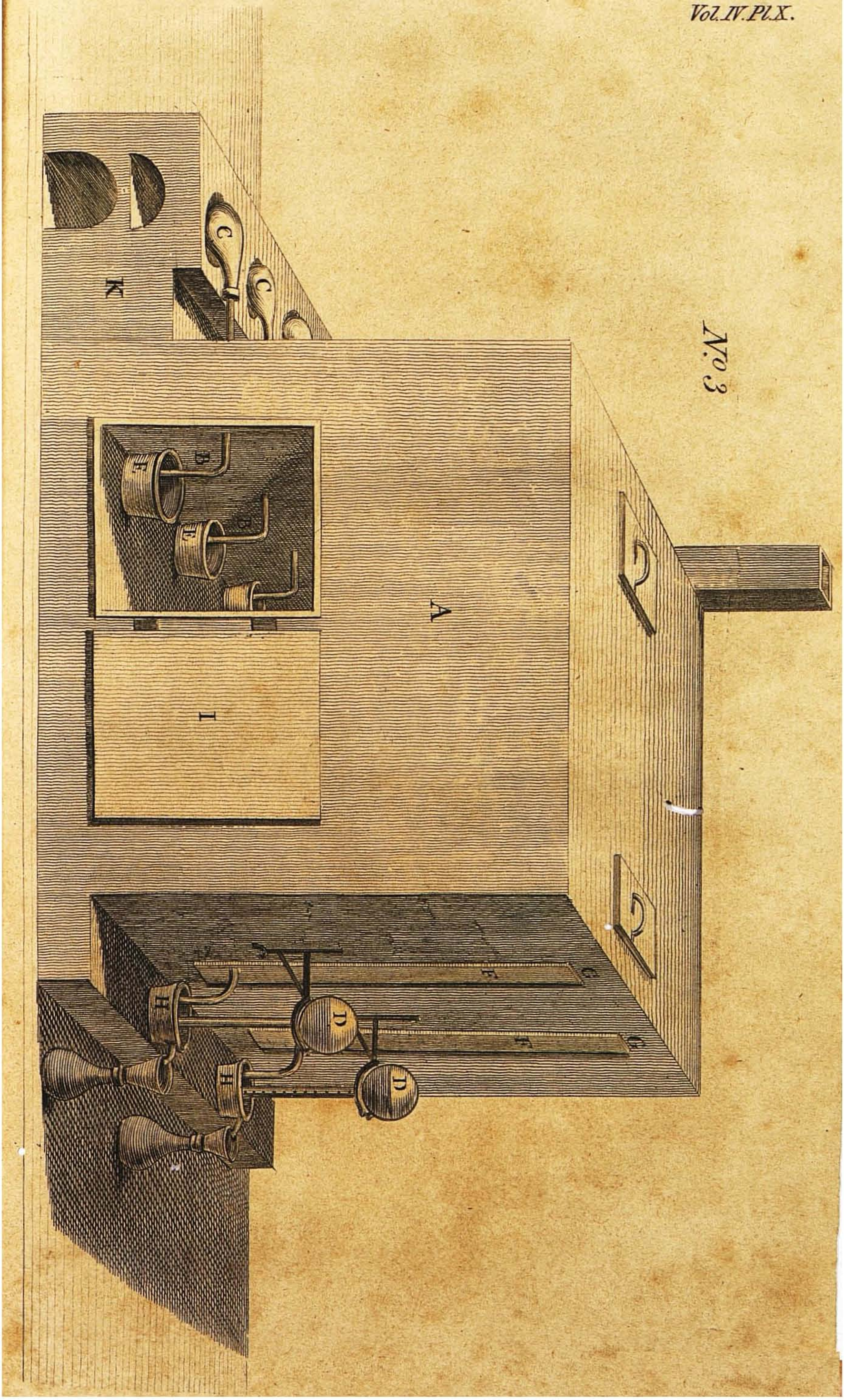

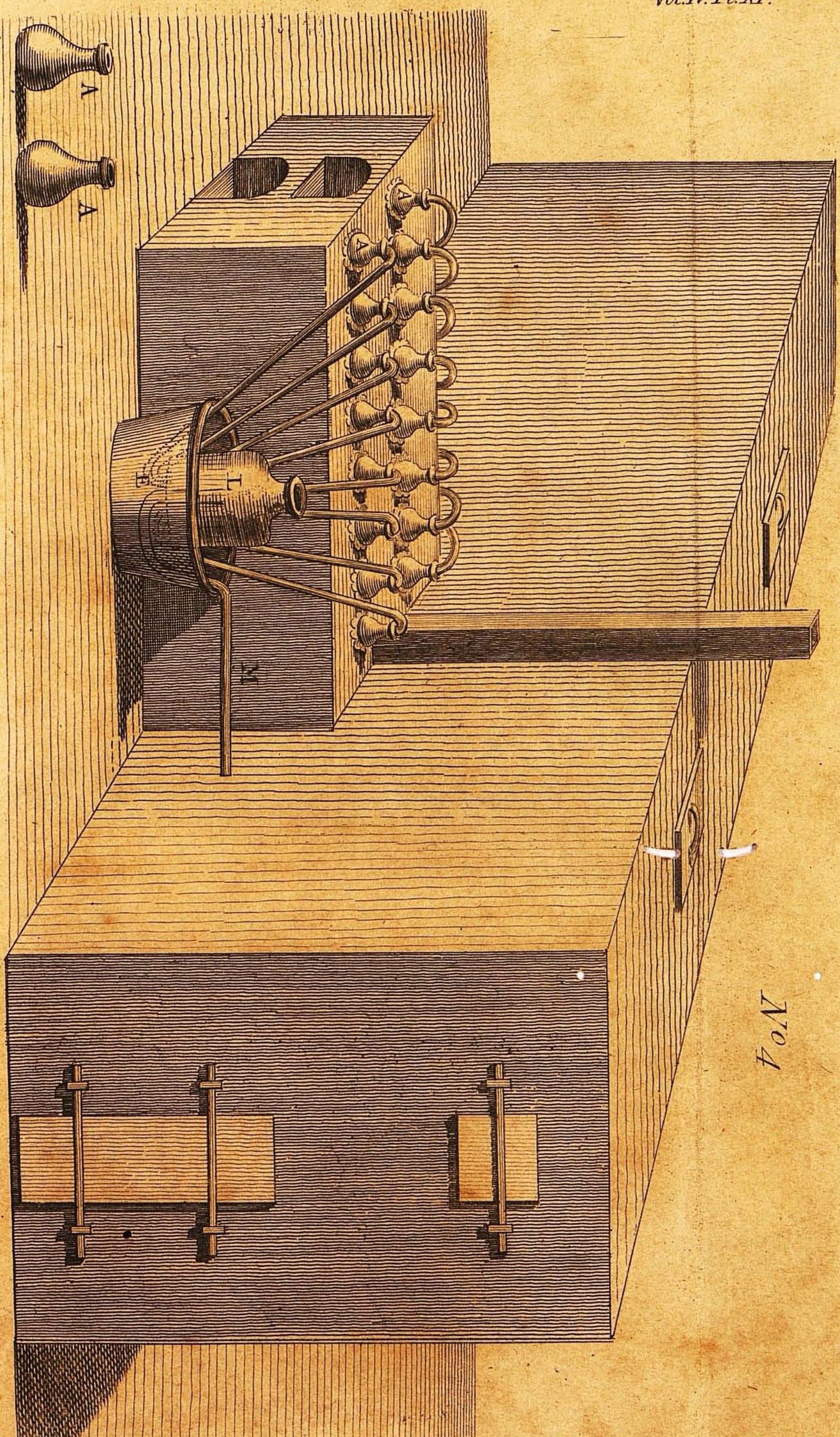
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XX. *Specification of the Patent granted to Mr.* Robert Barker, *of the City of Edinburgh, Portrait-Painter; for his Invention of an entire new Contrivance or Apparatus, called by him* La Nature à Coup d'Œil *, *for the Purpose of displaying Views of Nature at large, by Oil-Painting, Fresco, Water-colours, Crayons, or any other Mode of painting or drawing.*

Dated June 19, 1787.

To all to whom these presents shall come, &c. Now know ye, that by my invention, called *La nature à coup d'œil*, is intended, by drawing and painting, and a proper disposition of the whole, to perfect an entire view of any country or situation, as it appears to an observer turning quite round; to produce which effect, the painter or drawer must fix his station, and delineate correctly and connectedly every object which presents itself to his view as he turns round, concluding his drawing by a con-

* This invention has been since called the *Panorama*.

nection

nection with where he began. He muſt obſerve the lights and ſhadows, how they fall, and perfect his piece to the beſt of his abilities. There muſt be a circular building or framing erected, on which this drawing or painting may be performed; or the ſame may be done on canvas, or other materials, and fixed or ſuſpended on the ſame building or framing, to anſwer the purpoſe complete. It muſt be lighted entirely from the top, either by a glazed dome or otherwiſe, as the artiſt may think proper. There muſt be an incloſure within the ſaid circular building or framing, which ſhall prevent an obſerver going too near the drawing or painting, ſo as it may, from all parts it can be viewed, have its proper effect. This incloſure may repreſent a room, or platform, or any other ſituation, and may be any form thought moſt convenient, but the circular form is particularly recommended. Of whatever extent this inſide incloſure may be, there muſt be over it, (ſupported from the bottom, or ſuſpended from the top,) a ſhade or roof; which, in all directions, ſhould project ſo far beyond this incloſure, as to prevent an obſerver ſeeing above the

drawing

drawing or painting, when looking up; and there muſt be without this incloſure another interception, to repreſent a wall, paling, or other interception, as the natural objects repreſented, or fancy, may direct, ſo as effectually to prevent the obſerver from ſeeing below the bottom of the drawing or painting, by means of which interception nothing can be ſeen on the outer circle, but the drawing or painting intended to repreſent nature. The entrance to the inner incloſure muſt be from below, a proper building or framing being erected for that purpoſe, ſo that no door or other interruption may diſturb the circle on which the view is to be repreſented. And there ſhould be, below the painting or drawing, proper ventilators fixed, ſo as to render a current circulation of air through the whole; and the inner incloſure may be elevated, at the will of an artiſt, ſo as to make obſervers, on whatever ſituation he may wiſh they ſhould imagine themſelves, feel as if really on the very ſpot. In witneſs whereof, &c.

XXI.

XXI. *Specification of the Patent granted to Mr.* Samuel Unwin, *of Ashfield, in the County of Nottingham, Merchant; for his Invention of rendering Soap-suds, after being used in scowering, cleansing, &c. of sufficient Efficacy to serve again for those or the like Purposes, and to make Soap therefrom.*

Dated June 14, 1780.—Term expired.

To all to whom these presents shall come, &c. Now know ye, that, in compliance with the said proviso, I the said Samuel Unwin do hereby declare, that my said invention of rendering soap-suds, after they have been used in scowering, cleansing, or discharging, of sufficient efficacy to serve again, for the same or the like purposes, and to make soap therefrom, is described as is herein after mentioned; that is to say, that the said soap-suds, after having been used in scowering, cleansing, or discharging the oil, grease, gum,

gum, or other matter uſually contained in, or adhering to, any wool, ſilk, linen, cotton, or any other materials, manufacture, or goods, which uſually require ſcowering, cleanſing, or diſcharging, till rendered unfit to perform effectually the like operation, by reaſon of the ſaid ſuds being ſurcharged with oil, greaſe, gum, or other matter, together with dirt or earthy particles diſcharged thereinto from the ſaid materials or goods, are put into a dreſs-pan or boiler, under which a fire being made, and the ſuds thereby heated to or near a boiling heat, a ſcum of oil, greaſe, gum, or other like matter having a dirty appearance, will ariſe to the ſurface thereof; which ſcum, together with all the ſuperfluous oil, greaſe, gum, or other like matter contained in the aforeſaid ſuds or liquid, muſt be ſaturated or diſſolved by adding thereto pot-aſhes, or other alkaline ſalts, or matter having the like nature or properties, or lies made thereof or of the ſoluble part of lime, or lime and alkaline ſalts mixed together; which muſt be put into the copper or boiler containing the ſuds, by little and little, ſtirring and mixing the ſame well together, and con-

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tinuing them at a very ſtrong heat, till the ſcum ſhall totally diſſolve and diſappear; which diſappearance of ſcum, and appearance of foam or froth in the place thereof, are proofs that the alkaline ſalt, or other like matter, ſo added, has ſaturated or diſſolved the ſaid ſuperfluous oil, greaſe, gum, or other matter as aforeſaid.

The quantity of alkaline ſalt required cannot be exactly aſcertained, by reaſon that the ſuds will be more or leſs charged with ſuperfluous oil, greaſe, gum, or other like matter, and the alkaline ſalt being of different degrees of purity; but, if pure, one ounce of ſalt, or leſs, if rendered more cauſtic by means of lime, will be ſufficient to rectify the ſuds for each pound of wool that has been ſcowered therein, ſuppoſing ſuch wool to contain about two ounces of oil, greaſe, gum, or other matter as aforeſaid. The ſuds being thus partly ſaturated or corrected with alkaline ſalts, or other matter having the like nature or properties, muſt be continued at a ſtrong heat, or boil, for one or two hours or more, according to the largeneſs of the pan, or briſkneſs and ſtrength of the fire under it; after which the fire muſt be

diſcon-

discontinued, that the earthy part which was discharged from the wool, or other materials or goods, into the suds may, as the heat decreases, precipitate to the bottom of the pan, and leave the rectified suds or composition, in the upper part thereof, in purity. The suds will then be found in a fit state for scowering, cleansing, or discharging, as may be proved by a trial being made thereof for the purpose of scowering, cleansing, or discharging, in the same manner as with suds made from soap dissolved in water. The said suds are not to be thrown away after having been once rectified, but may be used and rectified time after time by the means described; the quantity or efficacy always increasing with every additional operation, in proportion to the quantity of oil, grease, gum, or other matter added by each scowering, and the salt and other matter required to correct the same.

To make soap of the above rectified suds or composition, draw off from the deep pan or vessel in which they have been rectified, with a crane or pipe added to the pan or vessel for the like purpose, as much of this liquid as can

be got therefrom, without diſturbing or mixing therewith the grounds or earthy parts that have precipitated to, or remain at or near, the bottom; which put into a ſhallow pan, and with a fire evaporate as much of the watery part as may be neceſſary to bring the ſaid rectified ſuds or compoſition to the conſiſtence uſually required for ſoap; add thereto the uſual proportion of marine ſalt, as practiſed by ſoap-makers in the common method, in order that the watery part may be more effectually ſeparated from the ſubſtance, which will then become hard ſoap, having the uſual properties of that article. But for ſoft ſoap no marine ſalt is neceſſary, the ſimple rectified ſuds, evaporated to a proper degree of conſiſtence, becoming thereby the ſame, or having the like uſes, as ſoft ſoap made from the uſual ingredients. In witneſs whereof, &c.

XXII.

XXII. *Defcription of a farther Improvement of the common Spinning-wheel, by which the Inaccuracies of the Movement are effectually obviated; the Friction of the whole Machine confiderably abated; and the Mode of adjufting the Velocity of the Bobbin to the quantity of thread thereon rendered more accurate; by Mr.* JOHN ANTIS, *of Fulneck, near Leeds* *.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Fifteen Guineas was voted to Mr. ANTIS for this farther Improvement of the Spinning-wheel; which is defcribed in the following abftract of a Letter from him.

I WILL now, according to your defire, explain myfelf, as well as I can, upon the fubject

* For an account of Mr. Antis's former improvement of the fpinning-wheel, fee our firft volume, page 37, where a defcription of it, with a plate, is given.

of

of my laſt improvement of the common ſpinning-wheel. After having made my former improvement of a ſliding bobbin, I completed a wheel on that principle: this gave me an opportunity to obſerve how the firſt invention, and, in ſhort, how the whole wheel, acted; and induced me to make the following obſervations on thoſe parts which I thought would admit of ſtill farther improvement.

Firſt. Beſides the diſagreeable catch which the pinion with one leaf gave at every revolution of the wheel, the bobbin moved only by ſudden jerks, and did not lay the thread on it ſo even as might be wiſhed: to remedy this, I adopted the motion of an endleſs ſcrew, working a toothed wheel with a heart-ſhaped piece of braſs fixed thereon.

Secondly. As the ſpinner muſt be always perfectly at liberty to hold the thread at pleaſure, and not to let it in until it is ſufficiently twiſted, I obſerved, that as the bobbin moved upon a ſquare, the holding of the thread ſo affected it, particularly when the bobbin began to be filled, and conſequently

ſequently the purchaſe was farther from the centre, that it became quite ſtiff upon the ſquare, and incapable of moving, notwithſtanding the action of the weight; and afterwards, when the thread was left at liberty, it would jump at once half an inch, or more: and this would invariably have been the caſe with every other contrivance of the kind which might be ſubſtituted; as for inſtance, a cylinder with a rib, &c. &c. except the weight had been much heavier, which would have occaſioned a greater friction on the machine.

Thirdly. Beſides what has been obſerved above, it is well known, that in all wheels upon the old plan, as well as in thoſe with my firſt improvement, there was no other way to increaſe the friction of the bobbin, and make it take in more or leſs in proportion to the quantity of thread thereon, than by ſtretching or tightening the double cord; and this could never be done but at the expence of making the wheel go heavier and heavier, ſo that it became quite troubleſome when the bobbin was nearly filled. The ſame effect followed in ſome wheels that I have ſeen, which were made with a ſingle cord, having another added,

added, to occaſion a preſſure on the neck of the bobbin, whereby the friction was increaſed or diminiſhed; becauſe the ſame degree of preſſure it made upon the bobbin was alſo made upon the ſpindle, or upon a ſtud on which the bobbin turned, as in the ladies common ſpinning-wheels. As this latter method could not be uſed with a ſliding bobbin, I was under the neceſſity of contriving a new mode, by which the one was made quite independent of the other, ſo that the bobbin might move to and fro with the greateſt freedom, and there might be a means of increaſing the friction without any effect on the velocity of the whole machine. After various trials, I hit upon the preſent plan, viz. to make uſe of a ſingle cord, which has only to turn the flyer, therefore needs no ſcrew to tighten it; for, ſhould it even, in time, become ſo ſlack as not to do its duty, it may eaſily be tied or ſtitched a little ſhorter.

In order to regulate the friction on the bobbin, there is a neck of braſs or ſteel faſtened to one end of it, of which a vice or pincher, fixed to the ſliding-bar, takes hold. This vice muſt be made either of

two elaſtic ſprings with wooden tops, or of wood wholly, and buſhed with leather; but, if of wood only, then a ſpring muſt be made under the ſhoulder of the ſcrew, to anſwer the ſame purpoſe. By tightening this ſcrew more or leſs, the friction may be regulated to the greateſt nicety, provided the ſprings are of a ſtrength rightly proportioned to their functions. It will readily appear that all this may be done without the leaſt effect on the velocity of the whole machine, as thereby nothing is added to the general friction, ſo as to obſtruct it: ſuch a wheel will therefore be found to run much more freely than one with a double cord; and this muſt be conſidered a great advantage to a ſpinner who is obliged to ſpin the whole day for her living.

Theſe are the chief advantages aimed at by the preſent invention, and all who have ſeen and tried it here think it as great an improvement on my former wheel as that was upon the common ſpinning-wheel.

XXIII. *Account of an Improvement in Sea-compaſſes; by Mr.* Bernard Romans, *of Penſacola.*

From the Transactions of the American Philosophical Society.

THE common mariner's compaſs has always appeared to accurate obſervers as an imperfect inſtrument, but in nothing has it proved to be more defective than in its uſe in ſtorms; the heavieſt braſs compaſſes now in uſe are by no means to be relied on in a hollow or high ſea. This is owing to the box hanging in two braſs rings, confining it to only two motions, both vertical, and at right angles with each other; by which confinement of the box, upon any ſuccuſſion, more eſpecially ſudden ones, the card is always put into too much agitation, and, before it can well recover

ver itſelf, another jerk prevents its pointing to the pole; nor is it an extraordinary thing to ſee the card unſhipped by the violence of the ſhip's pitching.

All theſe inconveniences are remedied to the full, by giving the box a vertical motion at every degree and minute of the circle, and compounding theſe motions with a horizontal one, of the box, as well as of the card. By this unconfined diſpoſition of the box, the effects of the jerks on the card are avoided, and it will always very ſteadily point to the pole. Experience has taught me, that the card not only is not in the ſmalleſt degree affected by the hollow ſea, but that, in all the violent ſhocks and whirlings the box can receive, the card lies as ſtill as if in a room unaffected by the leaſt motion.

Lately a compaſs was invented and made in Holland, which has all theſe motions. It is of the ſize of the common braſs compaſſes; the bottom of the braſs box, inſtead of being like a bowl, muſt be raiſed into a hollow cone, like the bottom of a common glaſs bottle; the vertex of the

cone muſt be raiſed ſo high as to leave but one inch between the card and the glaſs; the box muſt be of the ordinary depth, and a quantity of lead muſt be poured in the bottom of the box, round the baſe of the cone; this ſecures it on the ſtile whereon it traverſes.

This ſtile is firmly fixed in the centre of a ſquare wooden box, like the common compaſs, except that it requires a thicker bottom. The ſtile muſt be of braſs, about ſix inches long, round, and of the thickneſs of one third of an inch; its head blunt, like the head of a ſewing-thimble, but of a good poliſh: the ſtile muſt ſtand perpendicular. The inner vertex of the cone muſt alſo be well poliſhed; the vertical part of the cone ought to be thick enough to allow of a well-poliſhed cavity, ſufficient to admit a ſhort ſtile, proceeding from the centre of the card whereon it traverſes. The compaſs I ſaw was ſo conſtructed; but I ſee no reaſon why the ſtile might not proceed from the centre of the vertex of the cone, and ſo be received by the card the common way. The needle muſt be a magnetic

bar,

bar, blunt at each end; the glaſs and cover are put on in the common way.

A compaſs of this kind was given by the captain of a Dutch man-of-war to captain Barnaby of the Zephyr ſloop: this gentleman gave it to me to examine, and was very profuſe in his encomiums thereon, ſaying, that in a very hard gale, which laſted ſome days, there was no other compaſs of any ſervice at all: indeed, to me it appears to deſerve all the praiſe he gave it.

XXIV. *Conclufion of Sir* Benjamin Thompson's *Experiments upon Heat.*

(from p. 136.)

In the laft experiment, (No. 30,) the refult of which was fo very extraordinary, the inftrument was cooled to 0° in thawing ice, after which it was plunged fuddenly into boiling water, where it remained till the inclofed thermometer had acquired the heat of 70°, which took up no lefs than 2456 feconds, or above 40 minutes; and it had remained in the boiling water full a minute and a half before the mercury in the thermometer fhewed the leaft fign of rifing. Having at length been put into motion, it rofe very rapidly 40 or 50 degrees; after which its motion, gradually abating, became fo flow, that it took up 1584 feconds, or fomething more than 26 minutes, in rifing from 60° to 70°, though the temperature of the medium in which it was placed during the whole

whole of this time was very nearly 80°; the mercury in the barometer ſtanding but little ſhort of 27 Paris inches.

All the different ſubſtances which I had yet made uſe of in theſe experiments, for ſurrounding or covering the bulb of the thermometer, fluids excepted, had, in a greater or in a leſs degree, confined the heat, or prevented its paſſing into or out of the thermometer ſo rapidly as it would have done, had there been nothing but air in the glaſs globe, in the centre of which the bulb of the thermometer was ſuſpended. But the great queſtion is, how, or in what manner, they produced this effect.

And firſt, it was not in conſequence of their own non-conducting powers, ſimply conſidered; for, if inſtead of being only bad conductors of heat, we ſuppoſe them to have been totally impervious to heat, their volumes or ſolid contents were ſo exceedingly ſmall, in proportion to the capacity of the globe in which they were placed, that, had they had no effect whatever upon the air filling their interſtices, that air would have been ſufficient to have conducted all the heat communicated,

nicated, in lefs time than was actually taken up in the experiment.

The diameter of the globe being 1,6 inches, its contents amounted to 2,14466 cubic inches; and the contents of the bulb of the thermometer being only 0,08711 of a cubic inch, (its diameter being 0,55 of an inch,) the fpace between the bulb of the thermometer and the internal furface of the globe amounted to 2,14466—0,08711= 2,05755 cubic inches; the whole of which fpace was occupied by the fubftances by which the bulb of the thermometer was furrounded in the experiments in queftion.

But, though thefe fubftances occupied this fpace, they were far from filling it; by much the greater part of it being filled by the air which occupied the interftices of the fubftances in queftion. In the experiment No. 4, this fpace was occupied by 16 grains of raw filk; and, as the fpecific gravity of raw filk is to that of water as 1734 to 1000, the volume of this filk was equal to the volume of 9,4422 grains of water; and, as one cubic inch of water weighs 253,185 grains, its volume was equal to $\frac{9,4422}{253,1856}$=0,037294 of a cubic

a cubic inch; and, as the ſpace it occupied amounted to 2,05755 cubic inches, it appears that the ſilk filled no more than about $\frac{1}{55}$ part of the ſpace in which it was confined, the reſt of that ſpace being filled with air.

In the experiment No 1, when the ſpace between the bulb of the thermometer and the glaſs globe, in the centre of which it was confined, was filled with nothing but air, the time taken up by the thermometer in cooling from 70° to 10° was 576 ſeconds; but in the experiment No 4, when this ſame ſpace was filled with 54 parts air and one part raw ſilk, the time of cooling was 1284 ſeconds.

Now, ſuppoſing that the ſilk had been totally incapable of conducting any heat at all, if we ſuppoſe, at the ſame time, that it had no power to prevent the air remaining in the globe from conducting it, in that caſe, its preſence in the globe could only have prolonged the time of cooling in the proportion of the quantity of air it had diſplaced to the quantity remaining; that is to ſay, as 1 is to 54, or a little more than 10 ſeconds. But the time of cooling was actually pro-

 longed

longed 708 ſeconds; (for, in the experiment No. 1, it was 576 ſeconds, and in the experiment No. 4 it was 1284 ſeconds, as has been juſt obſerved;) and this ſhews, that the ſilk not only did not conduct the heat itſelf, but that it prevented the air by which its interſtices were filled from conducting it; or at leaſt it greatly weakened its power of conducting it.

The next queſtion which ariſes is, How air can be prevented from conducting heat? and this neceſſarily involves another, which is, How does air conduct heat?

If air conducted heat as it is probable that the metals and water, and all other ſolid bodies and unelaſtic fluids conduct it; that is to ſay, if, its particles remaining in their places, the heat paſſed from one particle to another, through the whole maſs, as there is no reaſon to ſuppoſe that the propagation of heat is neceſſary in right lines, I cannot conceive how the interpoſition of ſo ſmall a quantity of any ſolid body, as $\frac{1}{55}$ part of the volume of the air, could have effected ſo remarkable a diminution of the conducting power of the

air

air, as appeared in the experiment (No. 4) with raw ſilk, above mentioned.

If air and water conducted heat in the *ſame manner*, it is more than probable that their conducting powers might be impaired by the ſame means; but when I made the experiment with water, by filling the glaſs globe, in the centre of which the bulb of the thermometer was ſuſpended, with that fluid, and afterwards varied the experiment, by adding 16 grains of raw ſilk to the water, I did not find that the conducting power of the water was ſenſibly impaired by the preſence of the ſilk.

But we have juſt ſeen that the ſame ſilk, mixed with an equal volume of air, diminiſhed its conducting power in a very remarkable degree; conſequently, there is great reaſon to conclude that water and air conduct heat in a *different manner*.

But the following experiment, I think, puts the matter beyond all doubt.

It is well known, that the power which air poſſeſſes of holding water in ſolution is augmented by heat, and diminiſhed by cold; and that, if

 hot

hot air is ſaturated with water, and if this air is afterwards cooled, a part of its water is neceſſarily depoſed. I took a cylindrical bottle, of very clear tranſparent glaſs, about 8 inches in diameter and 12 inches high, with a ſhort and narrow neck; and, ſuſpending a ſmall piece of linen rag, moderately wet, in the middle of it, I plunged it into a large veſſel of water, warmed to about 100° of Fahrenheit's thermometer, where I ſuffered it to remain till the contained air was not only warm, but thoroughly ſaturated with the moiſture which it attracted from the linen rag, the mouth of the bottle being well ſtopped up during this time with a good cork; this being done, I removed the cork for a moment, to take away the linen rag, and, ſtopping up the bottle again immediately, I took it out of the warm water, and plunged it into a large cylindrical jar, about 12 inches in diameter and 16 inches high, containing juſt ſo much ice-cold water, that when the bottle was plunged into it, and quite covered by it, the jar was quite full.

As the jar was of very fine tranſparent glaſs, as well as the bottle, and as the cold water contained

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in the jar was perfectly clear, I could see what passed in the bottle most distinctly; and, having taken care to place the jar upon a table near the window in a very favourable light, I set myself to observe the appearances which would take place, with all that anxious expectation which a conviction that the result of the experiment must be decisive naturally inspired. I was certain, that the air contained in the bottle could not part with its heat, without at the same time, that is to say, *at the same moment*, and *in the same place*, parting with a proportion of its water; if, therefore, the heat penetrated the mass of air from the centre to the surface, or *passed through it* from particle to particle, in the same manner as it is probable that it passes through water, and all other unelastic fluids, by far the greatest part of the air contained in the bottle would part with its heat when *not actually in contact with the glass*, and a proportional part of its water, being let fall at the same time, and in the *same place*, would necessarily descend in the form of rain; and, though this rain might be too fine to be visible in its descent, yet I was sure I should find it at the bottom

bottom of the bottle, if not in viſible drops of water, yet in that kind of cloudy covering which cold glaſs acquires from a contact with hot ſteam, or watery vapour.

But if the particles of air, inſtead of communicating their heat from one to another, from the centre to the ſurface of the bottle, each in its turn, and for itſelf, came to the ſurface of the bottle, and there depoſited its heat, and its water, I concluded that the cloudineſs occaſioned by this depoſit of water would appear all over the bottle, or, at leaſt, not more of it at the bottom than at the ſides, but rather leſs; and this I found to be the caſe in fact.

The cloudineſs firſt made its appearance upon the ſides of the bottle, near the top of it; and thence it gradually ſpread itſelf downwards, till, growing fainter as it deſcended lower, it was hardly viſible at the diſtance of half an inch from the bottom of the bottle; and upon the bottom itſelf, which was nearly flat, there was ſcarcely the ſmalleſt appearance of cloudineſs.

Theſe appearances, I think, are eaſy to be accounted for: the air immediately in contact with

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the glaſs being cooled, and having depoſited a part of its water upon the ſurface of the glaſs, at the ſame time that it communicates to it its heat, ſlides downwards by the ſides of the bottle in conſequence of its increaſed ſpecific gravity, and, taking its place at the bottom of the bottle, forces the whole maſs of hot air upwards; which, in its turn, coming to the ſides of the bottle, *there* depoſits its heat and its water; and afterwards, bending its courſe downwards, this circulation is continued till all the air in the bottle has acquired the exact temperature of the water in the jar.

Hence it is clear why the firſt appearance of condenſed vapour is near the top of the bottle; as alſo why the greateſt collection of vapour is in that part, and ſo very ſmall a quantity of it is found nearer the bottom of the bottle.

This experiment confirmed me in an opinion which I had for ſome time entertained, that though the particles of air individually, or each for itſelf, are capaple of receiving and *tranſporting* heat, yet air in a quieſcent ſtate, or as a fluid whoſe parts are at reſt with reſpect to each other, is not capable of conducting it, or giving it a paſſage; in

in ſhort, that heat is incapable of *paſſing through a maſs of air*, penetrating from one particle of it to another, and that it is to this circumſtance that its non-conducting power is principally owing.

It is alſo to this circumſtance, in a great meaſure, that it is owing that its non-conducting power, or its apparent warmth when employed as a covering for confining heat, is ſo remarkably increaſed upon being mixed with a ſmall quantity of any very fine, light, ſolid ſubſtance, ſuch as the raw ſilk, fur, eider-down, &c. in the foregoing experiments: for, as I have already obſerved, though theſe ſubſtances, in the very ſmall quantities in which they were made uſe of, could hardly have prevented, in any conſiderable degree, the air from conducting, or giving a *paſſage* to, the heat, had it been capable of paſſing through it, yet they might very much impede it in the operation of tranſporting it.

But there is another circumſtance which it is neceſſary to take into the account, and that is, the attraction which ſubſiſts between air and the bodies above mentioned, and other like ſubſtances, conſtituting natural and artificial clo-

 thing.

thing. For, though the incapacity of air to give a paſſage to heat, in the manner ſolid bodies and non-elaſtic fluids permit it to paſs through them, may enable us to account for its warmth under certain circumſtances, yet the bare admiſſion of this principle does not ſeem to be ſufficient to account for the very extraordinary degrees of warmth which we find in furs and in feathers, and in various other kinds of natural and artificial clothing, nor even that which we find in ſnow; for, if we ſuppoſe the particles of air to be at liberty to *carry off* the heat which theſe bodies are meant to confine, without any other obſtruction or hinderance than that ariſing from their *vis inertiæ*, or the force neceſſary to put them in motion, it ſeems probable that the ſucceſſion of freſh particles of cold air, and the conſequent loſs of heat, would be much more rapid than we find it to be in fact.

That an attraction, and a very ſtrong one, actually ſubſiſts between the particles of air and the fine hair or fur of beaſts, the feathers of birds, wool, &c. appears by the obſtinacy with which

these substances retain the air which adheres to them, even when immersed in water, and put under the receiver of an air-pump; and that this attraction is essential to the warmth of these bodies is, I think, very easy to be demonstrated.

In furs, for instance, the attraction, between the particles of air and the fine hairs in which it is concealed, being greater than the increased elasticity or repulsion of those particles with regard to each other, arising from the heat communicated to them by the animal body, the air in the fur, though heated, is not easily displaced; and this coat of confined air is the real barrier which defends the animal body from the external cold. This air cannot *carry off* the heat of the animal, because it is itself confined by its attraction to the hair or fur; and it transmits it with great difficulty, if it transmits it all, as has been abundantly shewn by the foregoing experiments.

Hence it appears why those furs which are the finest, longest, and thickest, are likewise the warmest; and how the fur of the beaver, of the otter, and of other like quadrupeds which live

much

much in water, and the feathers of water-fowls, are able to confine the heat of thoſe animals in winter, notwithſtanding the extreme coldneſs, and great conducting power, of the water in which they ſwim. The attraction between theſe ſubſtances and the air which occupies their interſtices is ſo great, that this air is not diſlodged even by the contact of water, but, remaining in its place, it defends the body of the animal, at the ſame time, from being wet, and from being robbed of its heat by the ſurrounding cold fluid; and it is poſſible that the preſſure of this fluid upon the covering of air confined in the interſtices of the fur, or feathers, may at the ſame time increaſe its warmth, or non-conducting power, in ſuch a manner that the animal may not, in fact, loſe more heat when in water than when in air; for we have ſeen, by the foregoing experiments, that, under certain circumſtances, the warmth of a covering is increaſed by bringing its component parts nearer together, or by increaſing its denſity even at the expence of its thickneſs: but this part will be farther inveſtigated hereafter.

Bears, wolves, foxes, hares, and other like quadrupeds, inhabitants of cold countries, which do not often take the water, have their fur much thicker upon their backs than upon their bellies. The heated air, occupying the interſtices of the hairs of the animal, tending naturally to riſe upwards, in conſequence of its increaſed elaſticity, would eſcape with much greater eaſe from the backs of quadrupeds than from their bellies, had not Providence wiſely guarded againſt this evil, by increaſing the obſtructions, in thoſe parts, which entangle it and confine it to the body of the animal. And this, I think, amounts almoſt to a proof of the principles aſſumed relative to the manner in which heat is carried off by air, and the cauſes of the non-conducting power of air, or its apparent warmth, when, being combined with other bodies, it acts as a covering for confining heat.

The ſnows which cover the ſurface of the earth in winter, in high latitudes, are doubtleſs deſigned by an all-provident Creator as a garment to defend it againſt the piercing winds from the

polar

polar regions, which prevail during the cold ſeaſon.

Theſe winds, notwithſtanding the vaſt tracts of continent over which they blow, retain their ſharpneſs as long as the ground they paſs over is covered with ſnow; and it is not till, meeting with the ocean, they acquire, from a contact with its waters, the heat which the ſnows prevent their acquiring from the earth, that the edge of their coldneſs is taken off, and they gradually die away and are loſt.

The winds are always found to be much colder when the ground is covered with ſnow than when it is bare, and this extraordinary coldneſs is vulgarly ſuppoſed to be communicated to the air by the ſnow; but this is an erroneous opinion, for theſe winds are in general much colder than the ſnow itſelf.

They retain their coldneſs becauſe the ſnow prevents them from being warmed at the expence of the earth; and this is a ſtriking proof of the uſe of the ſnow in preſerving the heat of the earth during the winter, in cold latitudes.

It

It is remarkable that these winds seldom blow from the poles directly towards the equator, but from the land towards the sea. Upon the eastern coast of North America the cold winds come from the north-west; but upon the western coast of Europe they blow from the north-east.

That they should blow towards those parts where they can most easily acquire the heat they are in search of, is not extraordinary; and that they should gradually cease and die away, upon being warmed by a contact with the waters of the ocean, is likewise agreeable to the nature and causes of their motion; and if I might be allowed a conjecture respecting the principal use of the seas, or the reason why the proportion of water upon the surface of our globe is so great, compared to that of the land, it is to maintain a more equal temperature in the different climates, by heating or cooling the winds which at certain periods blow from the great continents.

That cold winds actually grow much milder upon passing over the sea, and that hot winds are refreshed by a contact with its waters, is very certain; and it is equally certain that the winds from

from the ocean are, in all climates, much more temperate than thoſe which blow from the land.

In the iſlands of Great Britain and Ireland, there is not the leaſt doubt but the great mildneſs of the climate is entirely owing to their ſeparation from the neighbouring continent by ſo large a tract of ſea; and in all ſimilar ſituations, in every part of the globe, ſimilar cauſes are found to produce ſimilar effects.

The cold north-weſt winds, which prevail upon the coaſt of North America during the winter, ſeldom extend above 100 leagues from the ſhore, and they are always found to be leſs violent, and leſs piercing, as they are farther from the land.

Theſe periodical winds from the continents of Europe and North America prevail moſt towards the end of the month of February, and in the month of March; and I conceive that they contribute very eſſentially towards bringing on an early ſpring, and a fruitful ſummer, particularly when they are very violent in the month of March, and if at that time the ground is well covered with ſnow. The whole atmoſphere of the polar regions being, as it were, tranſported into

the ocean by theſe winds, is there warmed and ſaturated with water; and a great accumulation of air upon the ſea being the neceſſary conſequence of the long continuance of theſe cold winds from the ſhore, upon their ceaſing the warm breezes from the ſea neceſſarily commence, and, ſpreading themſelves upon the land far and wide, aſſiſt the returning ſun in diſmantling the earth of the remains of her winter garment, and in bringing forward into life all the manifold beauties of the new-born year.

This warmed air which comes in from the ſea, having acquired its heat from a contact with the ocean, is of courſe ſaturated with water; and hence the warm ſhowers of April and May, ſo neceſſary to a fruitful ſeaſon.

The ocean may be conſidered as the great reſervoir and equalizer of heat; and its benign influences in preſerving a proper temperature in the atmoſphere operate in all ſeaſons, and in all climates.

The parching winds from the land under the torrid zone are cooled by a contact with its waters; and, in return, the breezes from the ſea, which

which at certain hours of the day come in to the ſhores in almoſt all hot countries, bring with them refreſhment, and, as it were, new life and vigour, both to the animal and vegetable creation, fainting and melting under the exceſſive heats of a burning ſun. What a vaſt tract of country, now the moſt fertile upon the face of the globe, would be abſolutely barren and uninhabitable, on account of the exceſſive heat, were it not for theſe refreſhing breezes! and is it not more than probable, that the extremes of heat and of cold in the different ſeaſons in the temperate and frigid zones would be quite intolerable, were it not for the influence of the ocean in preſerving an equability of temperature?

And to theſe purpoſes the ocean is wonderfully well adapted, not only on account of the great power of water to abſorb heat, and the vaſt depth and extent of the different ſeas, (which are ſuch that one ſummer or one winter could hardly be ſuppoſed to have any ſenſible effect in heating or cooling this enormous maſs,) but alſo on account of the continual circulation which is carried on in the ocean itſelf, by means of the currents which

prevail in it. The waters under the torrid zone, being carried by these currents towards the polar regions, are there cooled by a contact with the cold winds; and, having there communicated their heat to these inhospitable regions, return towards the equator, carrying with them refreshment for those parching climates.

The wisdom and goodness of Providence have often been called in question, with regard to the distribution of land and water upon the surface of our globe, the vast extent of the ocean having been considered as a proof of the little regard that has been paid to man in this distribution. But, the more light we acquire relative to the real constitution of things, and the various uses of the different parts of the visible creation, the less we shall be disposed to indulge ourselves in such frivolous criticisms.

XXV.

XXV. *Description of a Steam-Engine for raising Water without a Piston, proposed for draining the Marshes which are situated between the Lakes of Neuchatel, Bienne, and Morat; by M. François, Professor of Philosophy.*

WITH A PLATE.

From the MEMOIRS of the PHILOSOPHICAL SOCIETY of LAUSANNE.

SOME members of the government having consulted me respecting the draining of a considerable extent of marshy land, between the lakes of Neuchatel, Bienne, and Morat, I first considered whether I could not, for that purpose, employ the method which is used with so much success by the Dutch; this method consists in surrounding with banks the land which is intended to be drained, and placing, at certain distances,

wind-mills which draw off the waters within, and pour them into canals formed on the other ſide of the bank.

An inſpection of the places, however, convinced me that it was impoſſible to make uſe of ſuch mills. Theſe marſhes are bounded on the eaſt and weſt by the mountains Jura and Jorat, which renders the direction of the wind very irregular, beſides which thoſe mills are ſubject to two very great inconveniences; the firſt, that, even in flat open countries, they do not go more than one third of the year; the ſecond, that they can only raiſe water to a moderate height, that is to ſay, to the height of the radius of the wheel. It is true that this inconvenience has been attempted to be remedied, by inclining the axis of the wheel, but, that being found to produce other inconveniences, it was thought neceſſary to recur to the horizontal axis.

It appears to me therefore, that for undertakings of this nature, we ſhould give up the idea of wind-mills, and, inſtead of them, make uſe of ſteam-engines. The Engliſh have, for a long time, employed

employed them with great advantage; the French, and other nations, begin now to bring them into uſe. Theſe conſiderations induced me to propoſe a machine, the conſtruction and effects of which I ſhall now proceed to deſcribe.

The machine is compoſed of the pipe A B, (Pl. XII.) part of which is plunged into the water: to this pipe is joined the cylinder or pump-body of iron C, the lower opening of which is cloſed by the valve D, which opens from D towards C. The diameter of C is ſix times as great as that of A B. E is a copper ſtill, two thirds filled with water, and placed upon a furnace; it communicates, by the tube F, with the upper part of the cylinder C. GH is a tube, through which the water is forced to riſe into the bucket I, which is ſuſpended by the centre K, upon which it turns; L is the counterpoiſe of the bucket. At M and N are two cocks. O P and O P are the arms of the regulator, which ſerve to open and ſhut the cocks. Q is the trough which carries off the water. R is the tube of ſupply, the inferior orifice of which is ſhut by the ſpring-valve S, which opens from S towards C.

Let

Let us now ſuppoſe the water boiling in the ſtill, the cocks M and N cloſed, and A B C filled with water *. It is evident that, as ſoon as the cocks are opened, the ſteam eſcapes through the tube F; it preſſes upon the ſurface of the water, the valves D and S are cloſed, and the water is forced to riſe from G to H, where it empties itſelf into the ſwinging-bucket I. This bucket, being filled, turns upon its axis, and empties itſelf into the trough Q; as ſoon as it is empty, it is brought back into its horizontal poſition, by the counterpoiſe L. The bucket, however, as it turns down, gives a motion to the two branches of the regulator, by which the cocks M and N are cloſed, and as it riſes opens them again. On the other hand, the trough Q, which receives the water from the bucket, gives a portion of it, at every turn, to the tube of ſupply R, which water, in falling, overcomes the reſiſtance of the ſpring-valve S; this water being cold, and falling into the cylinder C, condenſes the ſteam,

* The water will eaſily be made to riſe into the pump-body, by giving an oſcillatory movement to the bucket I.

and

and consequently occasions a vacuum; and the water which is in the tube A B, being forced up by the weight of the atmosphere, comes into its place. The cylinder C becomes then filled afresh, the cocks are opened, the steam escapes, and the water is again driven out; this takes place alternately, five or six times in a minute.

A view of this machine sufficiently shews its simplicity: it is subject neither to the friction of pistons, nor to the shaking of levers which rise and fall, as in the steam-engines made use of in England. It possesses in itself the principle of its regular motion; for, the bucket, being put in motion by the water which empties itself from it, causes the regulator to act, which opens and shuts the cocks, without the assistance of any person.

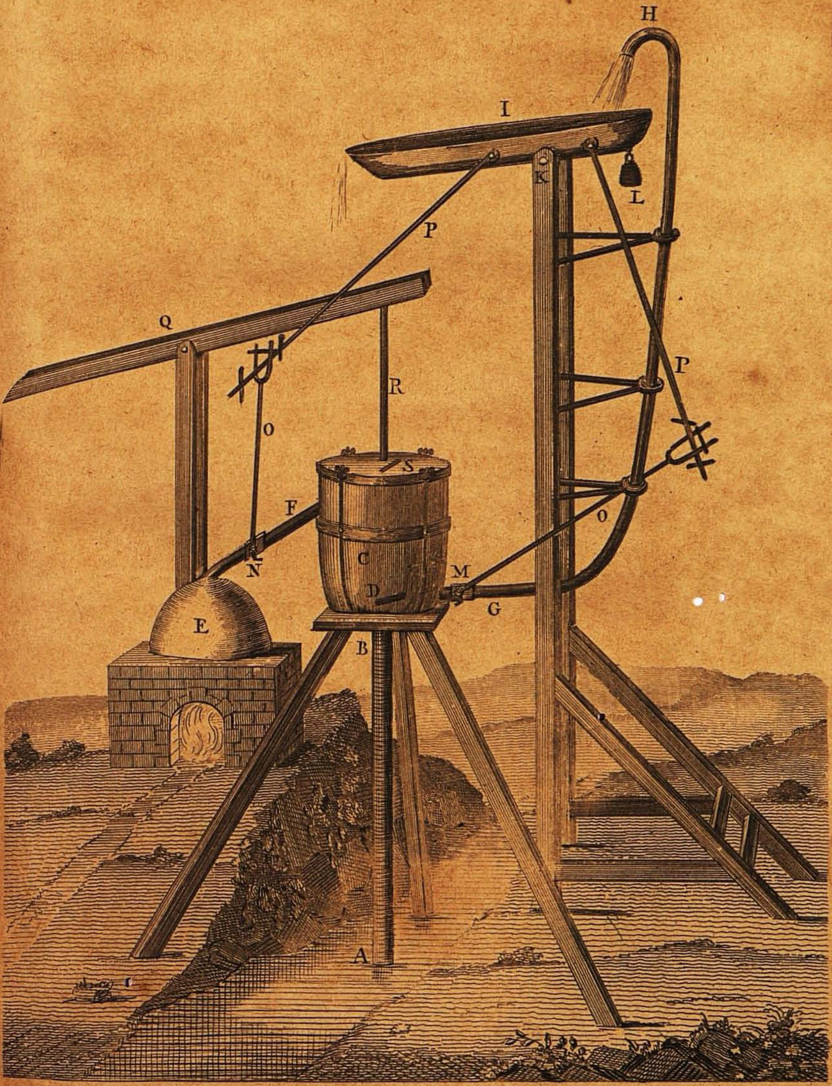
This machine can raise water at least fifty feet, reckoning thirty for the weight of the atmosphere, and twenty only for the action of the steam. Its power consists in the proportion which the capacity of the still bears to that of the cylinder above it. According to this proportion, the quantity

of

of water which goes out at each action may be estimated.

I have not thought it necessary to mention various particulars respecting the construction of the machine, such as the manner of giving the greatest possible strength to the still and cylinder, or how the fire-place may be most advantageously constructed for the saving of fuel; these objects are no doubt of great importance, but they are so well understood that it is unnecessary for me to say any thing about them here.

XXVI.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XXVI. *Experiments upon the Purification of crude Saltpetre, by means of Charcoal-powder; by Mr.* JOHN GADOLIN, *Member of the Royal Academy of Stockholm.*

From the TRANSACTIONS of the ſaid ACADEMY.

1. CRUDE ſaltpetre contains various heterogeneous ſubſtances, of which the principal are, ſea-ſalt, *ſal digeſtivum,* magneſia, and calcareous earth, all which are united to the nitrous acid; there is beſides a certain quantity of *greaſy matter*, which ſometimes is accompanied by volatile alkali. The different proportion which theſe ſalts bear with reſpect to the pure ſaltpetre, when cryſtallized, and the deliqueſcent nature of the forementioned earthy neutral ſalts, furniſh obvious means for ſeparating them from each other; but, ſo long as any conſiderable quantity of the

greaſy matter remains, it is impoſſible to obtain good cryſtals of ſaltpetre, or to ſeparate and extract from it the other ſpecies of ſalts.

II. The purification of crude ſaltpetre conſiſts principally in taking from it this greaſy matter. This operation is performed in the large way, to a certain degree, by keeping a concentrated ſolution of ſaltpetre boiling, ſo that the greaſy matter may be removed by ſkimming: but there is apt to remain in the ſaltpetre a ſufficient quantity of this matter to render it foul, which makes it neceſſary to repeat the operation ſeveral times, to bring the ſalt into ſuch a ſtate of purity as is ſufficient for common uſe.

III. Amongſt the means which have been hitherto propoſed for depriving ſaltpetre of this greaſy matter, the uſe of alum is probably the moſt certain; but, beſides its being too expenſive to be made uſe of in the large way, it would occaſion the ſaltpetre to be impregnated with vitriolic acid, if before its lixiviation it did not contain a ſufficiently large proportion of calcareous earth. It is therefore to be wiſhed that ſome proceſs could be diſcovered, by which ſaltpetre

might

might be deprived, at a ſmall expence, of its impurities.

IV. As charcoal-powder has lately appeared to poſſeſs the property of abſorbing thoſe impure greaſy matters which ſo often adhere to ſalts, (and even to ſpirituous liquors,) when it is digeſted or boiled with theſe ſubſtances *, I thought that a ſimilar

* Although it was already known that freſh-burnt charcoal poſſeſſed a particular diſpoſition to abſorb a certain quantity of air, and of ſome other ſubſtances with which it was ſurrounded, more experience was neceſſary before we could infer from that knowledge the application which might be made of the power of charcoal, to deprive fluid ſubſtances of thoſe viſcous, oily, or phlegmatic particles which are mixed with them, and which remain fixed in their pores when once they have introduced themſelves.

The improving of ſpirituous liquors, by throwing a certain quantity of birch-charcoal into the ſtill, during their diſtillation, has been boaſted of as an ingenious diſcovery. We have alſo been told of the advantage of letting a little ſoot from the chimney fall into beer while it was boiling; and that the beer became thereby remarkably clear: but theſe means, though ſo much extolled by ſome, have not been acknowledged as true by others; who, on the contrary, have abſolutely

ſimilar proceſs might very probably be made uſe of to purify ſaltpetre: with that view I made ſome

lutely abandoned them, or at leaſt omitted making uſe of them, until more knowledge reſpecting them ſhould be acquired by experiments properly made, and we ſhould be able to determine truly the value of the principle upon which the effect of theſe means depend.

Mr. Lowitz, of Peterſburgh, is probably the firſt perſon who publiſhed that, by means of charcoal, the acid of tartar, ſpirituous liquors, and many other ſubſtances might be freed from greaſy matter, and other ſimilar impurities. (*Act. Petropol.* Tom. V. Hiſt. p. 41. ibid Tom. VI. Hiſt. p. 57.) He ſuppoſes that there exiſts in charcoal a ſtrong diſpoſition to attract phlogiſton, as it does not loſe that principle by burning in a cloſe fire; and from that he infers the poſſibility of dephlogiſticating bodies, even in the moiſt way. By that he alſo explains his new method of purifying the forementioned ſubſtances. See *Crell's Chemiſche Annalen.* 1786, p. 233, 293. Item, 1788, p. 36, 131.

M. Piepenbring repeated Mr. Lowitz's Experiments with ſucceſs; (*Crell's Chem. Ann.* 1787, p. 157.) ſo alſo did Brugnatelli and Weſtrumb. (Ibid. 1789, p. 50.) But Mr. Fuchs, (ibid. 1788, p. 393.) Mr. Hahnemann, (ibid. 1789, p. 202.) and ſeveral others, after having in vain tried to deprive ſolutions of ſalts of their brown colour and viſcoſity by charcoal-powder,

ſome experiments, which I now ſubmit to the judgement of the academy.

V. I had twelve pounds of crude ſaltpetre, very brown and watery: at the bottom of the veſſel, in which I had put it, there had collected eleven *lods** of a watery brown matter, which I ſhall call *mother-water*, and which I ſeparated from the ſalt.

powder, combated Mr Lowitz's theory. Different ſubſtances would certainly be differently acted upon, in proportion to the purity of the charcoal; and the cauſe of their ill ſucceſs ſeems very much to have been owing, either to the charcoal not having been properly burnt, or to its having been rendered foul by ſome foreign vapours, before it was uſed in the experiments.

I have repeated ſome of Mr. Lowitz's experiments, and from them I conceived the hope of being able to make uſe of charcoal-powder to purify ſaltpetre; a purpoſe for which it has not, I believe, been hitherto uſed by any perſon. But the purity of ſaltpetre is an object of ſuch importance in making gunpowder, that I took the utmoſt care in conducting my experiments.

* A *lod* is $\frac{1}{32}$ of a Swediſh pound; it is rather leſs than half an ounce Engliſh, *i.e.* it is $\frac{1}{34}$ of a pound avoirdupois, or nearly ſo.

A.

A. I threw upon unſized paper eight *lods* of this crude ſaltpetre; it was kept in a moderate heat, that it might dry, after which it weighed only 7,15 lods.

B. I diſſolved one *lod* of crude ſaltpetre in water, and precipitated it by a ſolution of ſilver; the *luna cornea*, collected and put to dry, weighed, when dry, 0,0496 of a *lod*.

C. To five *lods* of crude ſaltpetre, diſſolved in water, I added a ſuperabundant quantity of fixed vegetable alkali. A ſmall quantity of precipitate, of a dark brown colour, was produced, which was not ſenſibly increaſed by being kept in a ſtrong digeſting heat; but there was perceived a faint ſmell of volatile alkali. The weight of the whole precipitate, collected together, was 0,013 of a *lod*.

D. One *lod* of the mother-water gave, with a ſolution of ſilver, a precipitate, which, after being put upon a filter, and dried, weighed 0,368 of a *lod*. The lie which paſſed through the filter, being ſuffered to evaporate, produced priſmatic cryſtals, ſome of which were deliqueſcent in the air, the others were pure ſaltpetre.

E.

E. From two *lods* of mother-water I obtained, by means of vegetable alkali, a precipitate of a light colour, which, after having been drained and dried, had the appearance of tripoli, and weighed 0,092 of a *lod*. This powder was dissolved by marine acid, with a violent effervescence, into a liquor of a clear, but dark, appearance; a greasy scum remained undissolved. The solution, when separated from this greasy matter by the filter, was clear, but became turbid by the addition of vitriolic acid; nevertheless, it became clear again after I had mixed a large quantity of water with it. I also poured some vitriolic acid alone upon the precipitate; a strong effervescence arose, and a powder, apparently of a gypseous nature, remained undissolved. The solution, being filtered, produced, by evaporation, long selenitic crystals, and crystals of Epsom salt.

F. Two *lods* of mother-water, being evaporated to dryness by a digesting heat, became a mass of a dark brown colour, full of irregular cubical crystals; it weighed 0,625 of a *lod*. Being

suffered

ſuffered to remain in a cold room, it attracted a certain quantity of moiſture. After being diſſolved in water and filtered, there remained upon the filter a quantity of ſediment hardly perceptible. I threw into the above mentioned ſolution a ſolution of mercury in nitrous acid, and I was ſtruck with an acetous ſmell which diſengaged itſelf. The ſolution loſt its dark colour, and became clear: it alſo let fall a conſiderable quantity of a white ſediment, the greateſt part of which diſſolved again when it was thrown upon the filter. What remained of it was of a browniſh yellow, which, by the blow-pipe, gave a ſmoke ſimilar to that of corroſive ſublimate; after that it changed into a black coal, which was quickly conſumed by the help of the blow-pipe, leaving only a ſmall quantity of aſhes.

TO BE CONLUDED IN OUR NEXT.

REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER XXII.

XXVII. *Specification of the Patent granted to* ANTHONY FAY, *of Bateman's Buildings, in the Parish of St. Anne, Soho, Esquire; for some considerable Improvements in the Art of tanning Leather, and in the Construction of Tan-yards.*

Dated July 17, 1790.

TO all to whom these presents shall come, &c. NOW KNOW YE, that, in compliance with the said proviso, I the said Anthony Fay do hereby declare, that my said invention of improvements in the art of tanning leather, and in the construc-

tion of tan-yards for that purpoſe, by which much time and labour will be ſaved, and the article produced at a much cheaper rate than by any of the modes now in uſe, is deſcribed in manner following; that is to ſay, that any bark or barks uſed in tanning leather (particularly oak-bark) ſhould be ground to a fine grain, in ſuch mill or mills as are uſed to grind ſtarch or drugs; that ſuch bark or barks ſo ground be put into a boiler proportioned to the quantity of bark to be boiled, allowing about two or three gallons of water to every pound weight of bark; but to be exact in this reſpect is of no great conſequence, only that the more water the more time is required in the decoction to concentrate and bring the bark to a ſtrong extract, as nothing is loſt of the qualities of the bark eſſential in tanning leather by ſuch decoction, the aqueous parts only are diſcharged by the ſteam, and the decoction muſt be repeated two, three, or four times, till the ſubſtance boiled becomes taſteleſs, and all the particles or qualities eſſential for tanning of leather ſhall be thoroughly extracted, which will be eaſily known

by

by the remaining ſubſtance becoming taſteleſs. This extract, by mixing with water, may be reduced to any degree of weakneſs, whereby an immenſe ſaving may be made in the carriage of bark, by obtaining the above extract where the bark or barks are ſtripped, or in the vicinity of ſuch place or places; and, with reſpect to the operation of tanning, it will be found that leather tanned by ſtrong oozes, produced from the above extract, will fill the pelts better than is done by any of the methods hitherto uſed; and it will render the offal of the pelts (hitherto of very inferior value) almoſt as good as any other part of the pelt; giving the leather a compactneſs, grain, ſtrength, and additional weight, ſuperior to the methods hitherto uſed, and on that account is peculiarly uſeful in tanning horſe and ſeal ſkins, together with all other pelts of a looſe and ſpongy nature; beſides that, in proportion to the ſtrength of the ooze made from the above extract, it will accelerate the tanning of leather, doing it at leaſt in one half of the time hitherto uſed in tanning the ſame, with leſs than one half of the quantity

 of

of bark hitherto ſpent in the operation of tanning; and, as a conſiderable proportion of the qualities eſſential for tanning leather remain unſpent in the refuſe of bark, called dry tan, by decoction, as before deſcribed, very conſiderable quantities of ooze may be obtained, but it muſt be obſerved that ſuch oozes muſt be perfectly cold before they are uſed. With reſpect to the formation and conſtruction of tan-yards, they ſhould be covered, and a crane placed in the centre of the building, whoſe jib or arm ſhould extend round the whoſe area of the building, whether round or ſquare; the ſtandard of the crane, a few inches above that part of the jib which is inſerted in the ſtandard, ſhould have an axis, and the ſame at the lower extremity of the ſtandard, ſo as to make a revolution round its own axis at pleaſure; the block, through which the pulley or rope paſſes, ſhould have a braſs ſheeve, which ſhould have one or more friction-wheels or caſtors placed between the centre and the axis on which it turns; the block containing the above ſheeve ſhould be ſo made as to paſs freely on caſtors, backwards and

and forwards, along the jib or arm of the crane, from one extremity of the jib to another, and placing two ſmall braſs pulleys, one at each extremity of the jib, and faſtening a ſmall cord to the block, which, paſſing through theſe ſmall pulleys, will move the block at pleaſure. As to the wheel or wheels near the lower part of the crane's ſtandard, their ſituation and uſes in raiſing weights are ſo commonly known that a particular deſcription of them is unneceſſary. By means of the above crane, whoſe ſize and power may be made in proportion to the weights to be raiſed *. It need not be added, that in very extenſive yards more cranes on the ſame conſtruction may be erected. As to the pits, I would recommend them to be circular, and a wheel placed in each, of the following form; ſuppoſe the two wheels of a carriage, with their axis, placed horizontally in the pit, making the lower extremity of ſuch axis of ſuch length as to keep the ſweep of the lower wheel at leaſt ſix inches from the bottom

* Compared with the record in the office.

of the pit; a fan of twigs, equal in length to a femidiameter or fpoke of the wheel, fhould be faftened to one of the loweft femidiameters, fo as to fweep the bottom of the pit at every revolution of the wheel. The diameter of this wheel fhould be eight inches fhorter than the diameter of the pit, fo that the outer or extreme circumference of the wheel fhould be four inches from the inner circumference of the pit. The pelts fhould be placed on the femidiameters of the wheel, either longitudinally or crofs-way, the fpoke paffing under the middle of the pelt, and fo on round the wheel; faftening the lower part of fuch pelts, fo placed, to fpokes or femidiameters below, anfwering in fituation to the upper fpokes, fo that there may not be the leaft, or not much, contact between any of the pelts. The upper circumference of the wheel fhould be furnifhed with equidiftant cogs, anfwering to the cogs of a fmall pinion-wheel placed on the fide of the pit, which may turn by a winch, fo as to move the wheel in the pit; or it may be fet in motion by a fcrew placed vertically on the fide of the pit, making, in that

cafe,

caſe, the cogs of the wheel bevil, to fit the ſloping hollow of the ſcrew, which may be put in motion by a winch; or, by attaching a barrel ſimilar to the barrel of a jack, it may be ſet in motion by a pulley or pulleys and weights, as a jack is, and wound up in the ſame manner. I would have the ſcrew made of ſycamore, (being not liable to warp,) and would have the cogs of the wheel made of the beſt oak. The depth and diameter of the pit need not be defined, as every tanner will make them ſo as to ſuit his own convenience; neither is it very neceſſary to ſay that the wheels ſhould be placed at ſuch diſtances from each other on the axis, as to ſuit the depth of half the pelt; and that every ſpoke or ſemidiameter will take one or more pelts, according to the length of ſuch ſemidiameters. There ſhould be fixed at the upper extremity of the axis of the wheel a ſtrong iron ring, which, being hooked by the crane, will raiſe or lower the whole wheel and its contents at pleaſure; by theſe means the ooze is kept in motion as often as the tanner pleaſes, which will greatly accelerate the proceſs of tan-

ning;

ning; ſuch cranes will be very uſeful in old tan-yards. Theſe circular pits and wheels ſhould be placed in circular lines round the crane, not ſunk in the earth, but elevated ſome feet above its ſurface; and ſo placed as the ſeats of galleries are, one higher than another, that they may be diſcharged into each other readily, as liquor-caſks are, by a crane or ſyphon; and each circular pit furniſhed with a cock at the bottom, to draw off the ooze. The covering the tan-yard will prevent weakening the ooze by rain, ſnow, &c. and, ſo far from leaving the pits always expoſed to the air, it will be found much better to have them cloſe covered. In the pits hitherto uſed it will be found a great advantage to frame the pelts, ſo that the leather may appear as the canvas does in a window-blind; and place them in the old ſquare pits ſo as not to touch each other, at leaſt as little as poſſible, whether placed horizontally, vertically, or obliquely. In ſuch pits, theſe (either the whole contents of the pit, or any one or more of ſuch frames) may be raiſed and lowered as eaſily, by the crane, as the wheel and its contents

above

above deſcribed; this will greatly accelerate the proceſs of tanning in the preſent tan-yards; for, the horizontal preſſure of ſuch ponderous bodies as large hides, over one another, exceedingly prevents the action of the ooze on the pelt. As no bark or dry tan will be brought into theſe new tan-yards, the eſſence or extracts of the bark or barks being only neceſſary, much room will be thereby ſpared, and the eſſence or extracts, water and oozes, eaſily conveyed to and from the pits by leather or other pipes. The *caput mortuum*, or wood which remains after the eſſence is taken, or extract made, from the bark or barks, will be more than ſufficient, as fuel, for making the decoction or decoctions. In witneſs whereof, &c.

XXVIII. *Specification of the Patent granted to Mr.* JAMES WATT, *of Birmingham, in the County of Warwick, Engineer; for certain newly-improved Methods of conſtructing Furnaces or Fire-places, for heating, boiling, or evaporating of Water, and other Liquids; which are applicable to Steam-Engines and other Purpoſes; and alſo for heating, melting, and ſmelting, of Metals, and their Ores; whereby greater Effects are produced from the Fuel, and the Smoke is in a great Meaſure prevented, or conſumed.*

WITH THREE PLATES.

Dated June 14, 1785.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, and in purſuance of the ſaid ſtatute, I the ſaid James Watt do hereby declare, that the following is a particular deſcription of the nature of

of my ſaid invention, and in what manner the ſame is to be performed; that is to ſay, my ſaid newly-improved methods of conſtructing furnaces or fire places conſiſt in cauſing the ſmoke or flame of the freſh fuel, in its way to the flues or chimney, to paſs, together with a current of freſh air, through, over, or among, fuel which has already ceaſed to ſmoke, or which is converted into coaks, charcoal, or cinders, and which is intenſely hot; by which means the ſmoke and groſſer parts of the flame, by coming into cloſe contact with, or by being brought near unto, the ſaid intenſely-hot fuel, and by being mixed with the current of freſh or unburnt air, are conſumed, or converted into heat, or into pure flame free from ſmoke. I put this in practice, firſt, by ſtopping up every avenue or paſſage to the chimney or flues, except ſuch as are left in the interſtices of the fuel, by placing the freſh fuel above, or nearer to, the external air than that which is already converted into coaks or charcoal; and by conſtructing the fire-places in ſuch manner that the flame, and the air which animates

the fire, muſt paſs downwards, or laterally, or horizontally, through the burning fuel, and paſs from the lower part, or internal end or ſide, of the fire-place, to the flues or chimney. In ſome caſes, after the flame has paſt through the burning fuel, I cauſe it to paſs through a very hot funnel, flue, or oven, before it comes to the bottom of the boiler, or to the part of the furnace where it is propoſed to melt metal, or perform other office, by which means the ſmoke is ſtill more effectually conſumed. In other caſes, I cauſe the ſame to paſs immediately from the fire-place into the ſpace under a boiler, or into the bed of a melting or other furnace. The drawing Figure 1 (Plate XIII.) ſhews a ſection of a fire-engine boiler, and its furnace or fire-place, which I have choſen for an example of the application of this new method to the heating and evaporating of water. A A is the boiler, which may be made of any form ſuitable to its uſe. B B is a flue, ſurrounding the boiler as uſual. C is the uptake, or paſſage from the ſpace under the boiler to the flues. D D is a funnel or flue for the

the flame to come from the fire-place to the boiler. E E is a place to contain the ashes; and F is a door to take them out at, which must be kept continually shut during the time of working. G H is the fire-place: the fresh fuel is put in at G, and gradually comes down as the fuel below consumes. The part at H is very hot, being filled with the coaks or coals which have ceased to smoke. I is an opening or openings, to admit fresh air, and regulate the fire. K is a door into the space under the boiler; which, being opened, admits air, and stops the draught of the chimney when the operation is wanted to cease. Figure 2 (Plate XIV.) is a section of the same fire-place in the other direction; in which M M is the back of the fire-place; L the brick arch on which the fuel lies; and E the ash-hole. Figure 3 is an outside view of the same fire-place, shewing the air-holes I I, and the ash-hole door F; and Figure 4 is a plan of the same, with part of the boiler seating, taking in the line Z Z of Figure 1. The dotted lines represent the flues, and the darts point out the direction of the flame.

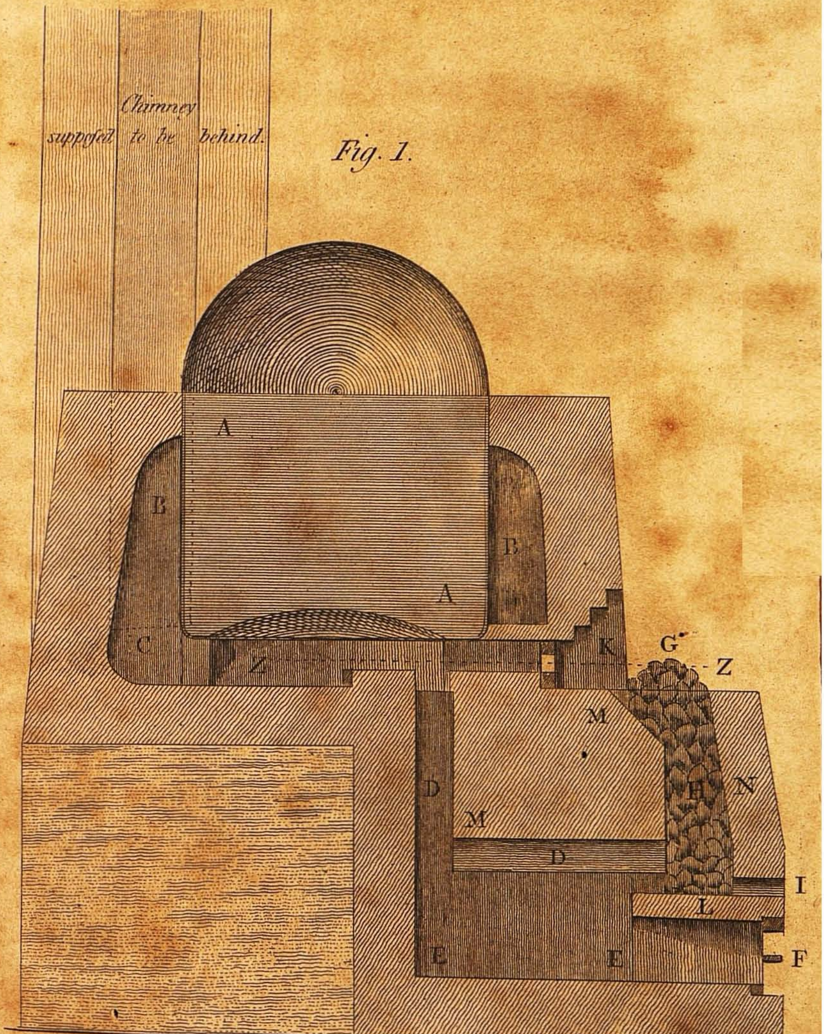
flame. The fire is firſt kindled upon the brick arch L, (Fig. 1.) and, when well-lighted, more fuel is gradually added until it is filled up to G; and care is taken to leave proper interſtices for the air to paſs, either among the fuel, or between the fuel and the front wall N; and as much air is admitted at II as can be done without cauſing the ſmoke to aſcend perpendicularly from G, which it will do if too much air is admitted at II. The dimenſions of this fire-place are ſhewn by the ſcale, and are properly adjuſted for burning about eighty-four pounds weight of coals in an hour; where greater or leſs quantities are required to be burnt, the furnaces muſt be enlarged and diminiſhed accordingly; or, if much greater, more furnaces than one can be employed. Figure 5. (Plate XV.) repreſents this new fire-place as applied to a furnace for melting iron and other metals, and conſtructed without the funnel or perpendicular flue D in Figure 1. N. B. The ſame letters refer to the ſame parts in all the preceding figures. I alſo conſtruct theſe new fire-places ſo that the part GH lies ſloping, or horizontal,

zontal, and otherwise vary the figure or form, and proportions, of the same; but, in all cases, the principle is the same; the fresh or raw fuel being placed next the external air, and so that the smoke or flame passes over, or through, the coaked or charred part of the fuel. I also occasionally cover the opening G, and cause the air to enter only, or principally, at II. Secondly, in some cases, I place the fresh fuel on a grate as usual, as at AA, (Figure 6,) and beyond that grate, at or near the place where the flame passes into the flues or chimneys, I place another smaller grate B, on which I maintain a fire of charcoal, coaks, or coals which have been previously burnt until they have ceased to smoke; which, by giving intense heat, and admitting some fresh air, consumes the smoke of the first fire. Lastly, be it remembered, that my said new invention consists only in the method of consuming the smoke, and increasing the heat, by causing the smoke and flame of the fresh fuel to pass through very hot funnels or pipes, or among, through, or near, fuel which is intensely hot, and

which has ceaſed to ſmoke; and by mixing it with freſh air when in theſe circumſtances; and in the form and nature of the fire-places herein mentioned, deſcribed, and delineated; the boilers, and other parts of the furnaces, being ſuch as are in common uſe. And be it alſo remembered, that theſe new-invented fire-places are applicable to furnaces for almoſt every uſe or purpoſe. In witneſs whereof, &c.

XXIX.

Fig. 1.



Scale for all the Figures

Fig. 2.

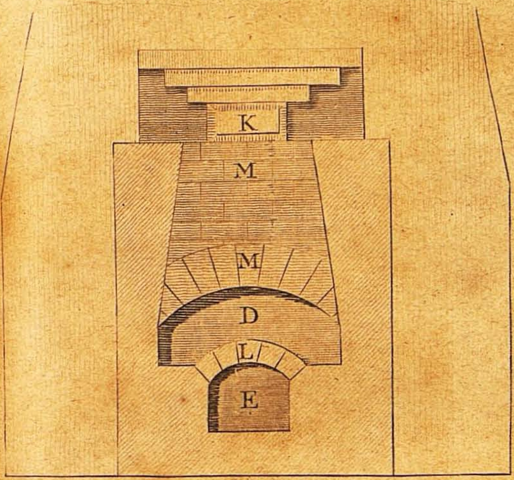


Fig. 3.

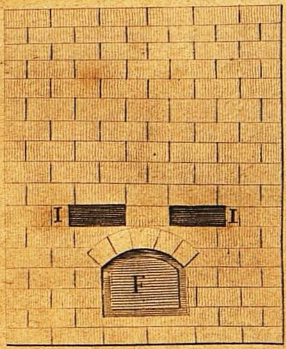


Fig. 4.

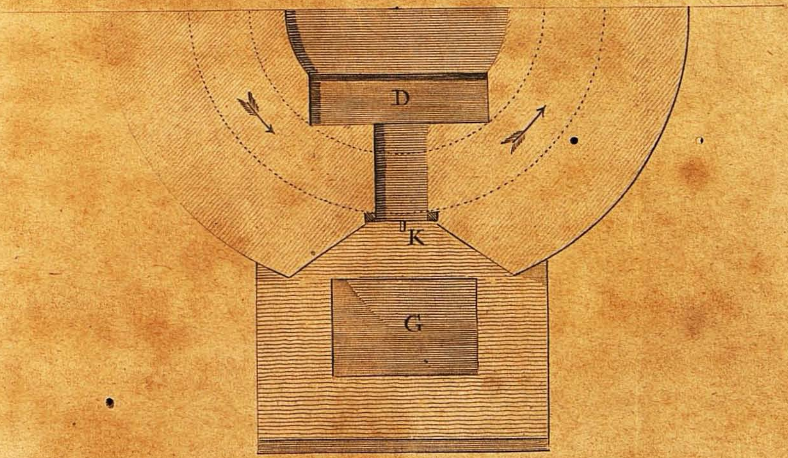


Fig. 5.

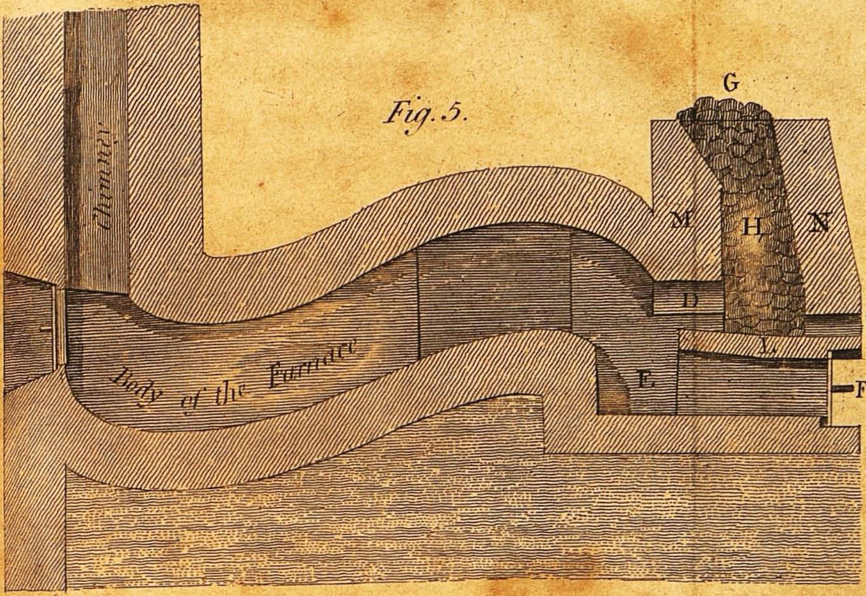
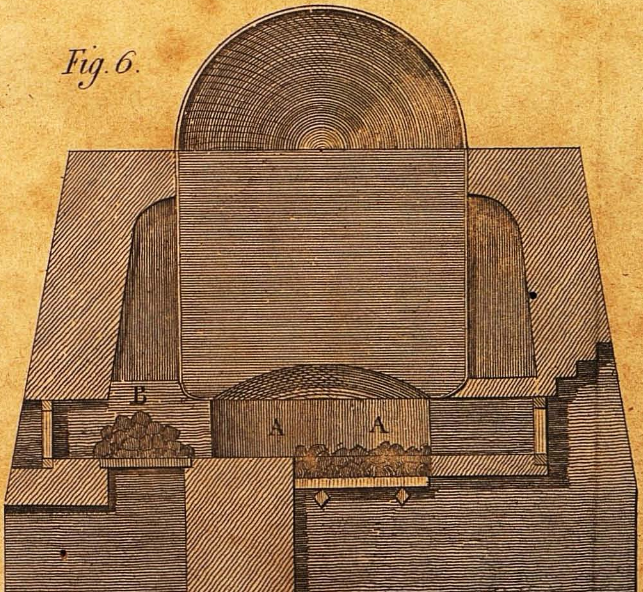


Fig. 6.



XXIX. *Specification of the Patent granted to Mr.* William Purnell, *of Durſley, in the County of Glouceſter, Ironmaſter; for an Invention communicated to him by the late John Purnell, of Froombridge Mills, in the ſame County, of an entire new Mode, Method, or Art, of preparing, ſhingling, and welding, Iron with Pit-coal from the Ore, as alſo from ſow or pig Metal, and every other Sort of Caſt-Iron, entirely by the Application of a Machine, conſtructed and applied ſo as to render it of a ſuperior Quality, and in much greater Quantities, and with a very conſiderably leſs Expence of Fuel, and Waſte of Metal, than hath hitherto been done by any Method yet uſed.*

Dated June 5, 1787.

To all to whom theſe preſents ſhall come, &c. Now know ye, that, in compliance with the ſaid proviſo, I the ſaid William Purnell do hereby

 declare,

declare, that the ſaid invention, and manner of performing the ſame, is deſcribed and aſcertained in manner following; that is to ſay, for the preparing, manufacturing, and working, of iron from the ore, as well as from ſow and pig metal, and alſo from every other ſort of caſt-iron, I uſe the common air, or reverberatory furnace, in manner as is practiſed at the common iron-foundaries; in which the metal muſt be brought into the moſt equable and perfect ſtate of fuſion, by being agitated here and there in the fire, ſo that every part may receive ſuch effect from it, that not the ſmalleſt particle may remain unmelted, or in an unfuſed ſtate; and, after that is completed, the heat muſt be abated by ſlow degrees, (ſtill keeping it ſtirred and ſeparated,) ſo that, as it cools gradually, it may be taken from the furnace in lumps, loops, or pieces, of about the weight of fourteen pounds, more or leſs, (as it may happen, or as the power of the rollers hereinafter deſcribed may beſt overcome,) or ſhovels made light, with their edges turned up, and rather diſhed in the middle, the better to prevent the hot metal falling off, whilſt

conveying

conveying from the furnace-mouth to a caſt-iron plate, placed on the floor, between the furnace-mouth and rollers, on which it muſt be laid down to receive a few blows from a common ſledge-hammer, by a labourer placed ready for that purpoſe, to bring it into ſomewhat of the ſhape of a wedge; when it muſt, with all poſſible diſpatch, be taken up by a man, who muſt attend before the rollers, with a ſhovel, like to that before deſcribed, or other ſuch tool or inſtrument, and conveyed to an iron plate, placed nearly in a direct line with the centre of a pair of iron rollers fixteen inches long by fifteen in diameter, or of ſuch other dimenſions as the force of the machinery uſed may render neceſſary, to be worked by ſteam, fire, or water; on which plate it is laid, and a blow or blows muſt be inſtantly given it by the edge of the ſaid ſhovel, or other ſuch tool, againſt the thickeſt edge or ſide, the better to force it to enter betwixt the rollers; (always obſerving that the thin edge of the lump or loop be preſented to paſs firſt;) and, whilſt this firſt lump or loop is paſſing betwixt the rollers, and falling

into a ciſtern through which a continual ſtream of water is made to paſs, another ſuch lump or loop muſt be prepared, and brought forward, in regular ſucceſſion, until the whole charge of one ſurface be rolled; which, in quantity, may be from three to five hundred weight, more or leſs, and which may be made to paſs between the ſaid iron rollers in about fifteen minutes; which, in the common method uſed, would take up much longer time, and be attended with a greater expence. But, ſhould a ſtill greater diſpatch in the rollers be required, a much larger quantity may be made to paſs between a pair of rollers in the ſame given time, by working them abreaſt, or parallel to each other, and letting the lumps or loops fall betwixt the rollers whilſt in motion, aided by a ſlight blow from a light ſledge-hammer, or even generally by their own weight. In which latter caſe, the diſpatch will be equal to the expedition with which the metal can be made to paſs to the rollers, either by means of the ſhovels, as before deſcribed, or by iron troughs and rakes, to convey it from the furnace to the rollers. The fur-

naces

naces to be placed in the moſt convenient ſituation to the rollers, that the hot metal may have but a ſhort diſtance to be conveyed to them from the furnaces, that it may paſs between them in a proper ſtate of heat, ſo that the rollers, by their ſuperior force, and uniform preſſure on all the parts of the hot crude metal, may ſqueeze, force out, and ſeparate from the true metallic part, the greateſt poſſible quantity of cinder, or obnoxious unmetallic earth; and which it does in a much ſuperior degree to any tilting forge, or other hammer or anvil, be their weight or force what it may, as I have experienced, or to any other method now practiſed, or that has been practiſed; and which renders the metal ſo worked and refined, by this my new-invented method of paſſing it whilſt in fuſion through a pair of rollers, inſtead of ſhingling under a tilting forge, or other hammer, or any other method now in uſe, perfectly pure and free from any obnoxious particles that by every other proceſs (that has hitherto been uſed) are in ſome degree left behind, and worked up in the interſtices of the metal; by which

which it never acquires ſo great a degree of malleability and ductility as by my new-diſcovered method of applying rollers, for the purpoſe of ſhingling and preparing iron for the balling forge, inſtead of the method of ſtamping and ſhingling with the tilting forge, or other hammer, or any other method that is or hath been hitherto practiſed. In witneſs whereof, &c.

XXX.

XXX. *Specification of the Patent granted to Mr.* WILLIAM STORER, *of Lisle-street, Leicester-Fields, in the County of Middlesex; for his Invention of an optical Instrument, called an* accurate Delineator, *which entirely obviates the Defects of the* Camera obscura, *as it may not only be used without the Assistance of the Sun, in the Day-time, but is also equally of use by Candle-light, for drawing the human Face, inside of Rooms, Buildings, &c. perspective Landscapes, Foliage and Fibres of Trees and Flowers; it exactly representing the same, large or small, with the true Outlines, Light, Shades, and Colours.*

Dated March 4, 1778.—Term expired.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said William Storer, in pursuance of the said proviso, do hereby describe my said invention in manner following; that

that is to ſay, the accurate delineator may be made in various forms, and the effects above mentioned ariſe from a new-invented application of lenſes, mirrors, ſpeculums, priſms, or mediums of lenſes, of glaſs, of any compoſition containing reflecting or refracting powers. The rays from the objects are at firſt received on, or conveyed to, a mirror or ſpeculum, placed at a proper angle in the inſide of a tube or box, by one or more convex lens, or medium of lenſes, before the mirror or ſpeculum. In caſes where the object is conveyed through a lens, or medium of lenſes, on the mirror or ſpeculum, one or more convex lenſes, or medium of lenſes, muſt be applied to correct and illuminate the rays, and to receive from the mirror or ſpeculum the rays from the objects conveyed thereon, through the firſt mentioned lens, or medium of lenſes; but, in caſes where the rays from the objects are received in the firſt place on the mirror or ſpeculum, a convex lens, or medium of lenſes, muſt be placed, fixed or movable, next after the mirror or ſpeculum, to collect the rays from the mirror

or

or ſpeculum; and, at a proper diſtance from the firſt lens, or medium of lenſes, muſt be applied one or more convex lens, or medium of lenſes, to correct and illuminate the rays from the firſt lens, or medium of lenſes; by which means all rays that are ſpherically refracted through the firſt medium will be made parallel, and conſequently all objects are accurately repreſented, and all parts thereof equally illuminated on the lens, or medium of lenſes, ſo receiving and correcting the rays of the objects received from the mirror or ſpeculum, or firſt lens, or medium of lenſes; which gives the moſt lively and exact repreſentation of the objects, either by the light of the ſun, moon, or any other light. In all caſes, the ſize of the aperture, or medium through which the rays firſt paſs, muſt govern the ſize and powers of the correcting lens, or medium, both contrary to the principles of the *camera obſcura*. A priſm, mirror, or ſpeculum, being placed at a proper angle to reflect the image on the firſt lens, or medium of lenſes, mirror, or ſpeculum, the objects will be repreſented in their true ſhape, figure, and form; and

 a col-

a collecting or correcting lens, or lenſes, or medium of lenſes, to collect or correct the rays from the images repreſented by a reflecting microſcope, magic-lantern, *camera obſcura*, or other inſtrument of the like nature, inſtantly forms the accurate delineator. The principles of the accurate delineator being not ſo much in the form or figure of the inſtrument, as to collect, and correct, and illuminate, the faint and imperfect rays from the objects received through theſe inſtruments. In witneſs whereof, &c.

XXXI.

XXXI. *Description of a Thrashing-Machine, with elastic Flails; invented by Mr.* James Wardrop, *of Ampthill, Virginia* *.

WITH A PLATE.

A. (Plate XVI. Fig. 1.) The floor over which the flails are fixed.

B. The part of the floor on which the grain is laid, made of wicker-work, through which the grain falls, and is conveyed to the fan or screen below; the pivot of the fan is seen at P, and is turned by a band from the wheel or wallower D.

* The following description and plate are taken from a work published in America; as that work is not to be procured here, we thought they would not be unacceptable to our readers. In our next number we propose to give, from the same work, a description and plate of a corn-mill, erected in Virginia, shewing several improvements lately made in the construction of such mills.

CCC. A thin board raiſed round the floor, to confine the wheat, and made ſhelving outwards, to render raking off the ſtraw more eaſy.

D. The wallower or wheel.

E. Crank handle to turn the wheel.

FFF. Flails.

GGG. Lifters, with ropes fixed to the flails.

HHH. Catches or teeth to raiſe the lifters.

I. Poſt, on which the wallower is fixed.

KK. Beam, on which the lifters reſt, which are fixed by an iron-rod paſſing through them, and let into this beam.

LL. Check-beam to ſtop the end of the lifters from riſing.

M. Beam, into which the ends of the flails are mortiſed.

NNN. Fly-ends loaded with lead, not neceſſary in a horſe machine.

Fig. 2 ſhews how the lifters work in the keeps OOO, and how both thoſe parts are fixed.

The machine, to be worked by two men, was made on a ſcale of a twelve-foot flail, having a ſpring which required a power of twenty pounds, to raiſe it three feet high at the point. A ſpring of this power, raiſed three feet high, being found to get out wheat with great effect.

The catches or teeth are ſtrongly mortiſed into the wallower-ſhaft, and placed round its circumference, ſo as to make an angle, one with another, of thirty degrees. Theſe catches or teeth take the lifters, which raiſe the flails, in an alternate manner; that is, three of the flails are operated upon with the whole power, (*viz.* 20 lb.) and are on the point of ſtriking; three of them are two-thirds raiſed; three of them one-third raiſed; and three of them at reſt; conſequently the whole weight to be overcome is 120 lb.

The lifters ſhould be placed ſo as that a perpendicular line from their lifting-end would come to the middle of the flail; the rope ſhould be fixed to the flail ſomewhat farther advanced to the end of it, that a proper tangent may be obtained; the ends of the lifters, and the teeth in the

the wallower, ſhould be rounded off, ſo as to form a tangent with each other.

The ropes ſhould be fixed to the flails with a hook and eye, to take off when not at work; for, ſome of the flails being always in a lifting ſtate, their elaſticity would otherwiſe be impaired.

The greater the length of the flails, and the higher they are raiſed, the more powerful they become; they act upon the floor, with effect, about one third of their length; conſequently, a flail twenty-four feet long will act on the floor, with force, eight feet; and this is the ſize of flails I would recommend in a horſe machine.

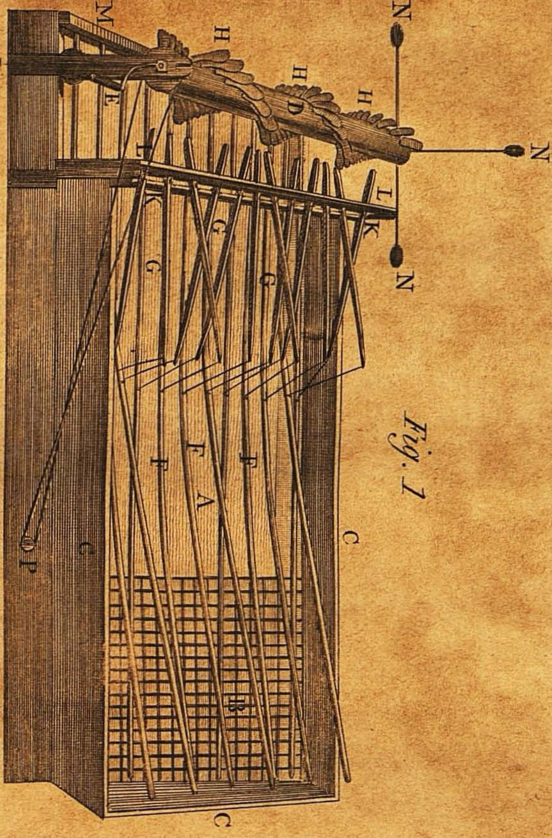


Fig. 1

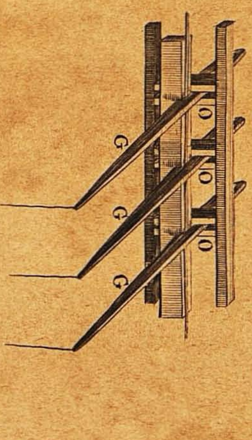


Fig. 2

XXXII. *Experiments made to determine the poſitive and relative Quantities of Moiſture abſorbed from the Atmoſphere, by various Subſtances, under ſimilar Circumſtances; by Sir* BENJAMIN THOMPSON, *Knt. F.R.S.*

From the TRANSACTIONS of the ROYAL SOCIETY of LONDON.

BEING engaged in a courſe of experiments upon the conducting powers of various bodies, with reſpect to heat, and particularly of ſuch ſubſtances as are commonly made uſe of for clothing, in order to ſee if I could diſcover any relation between the conducting powers of thoſe ſubſtances and their power of abſorbing moiſture from the atmoſphere, I made the following experiments.

Having provided a quantity of each of the under-mentioned ſubſtances, in a ſtate of the moſt perfect cleanneſs and purity, I expoſed them, ſpread out upon clean china plates, twenty-four hours

hours in the dry air of a very warm room, (which had been heated every day, for ſeveral months, by a German ſtove,) the laſt ſix hours the heat being kept up to 85° of Fahrenheit's thermometer; after which I entered the room with a very accurate balance, and weighed equal quantities of theſe various ſubſtances, as expreſſed in the following table.

This being done, and each ſubſtance being equally ſpread out upon a very clean china plate, they were removed into a very large uninhabited room, upon the ſecond floor, where they were expoſed forty-eight hours, upon a table placed in the middle of the room, the air of the room being at the temperature of 45° F.; after which they were carefully weighed, (in the room,) and were found to weigh as undermentioned.

They were then removed into a very damp cellar, and placed upon a table, in the middle of a vault, where the air, which appeared by the hygrometer to be completely ſaturated with moiſture, was at the temperature of 45° F.; and in this ſituation they were ſuffered to remain three days and three nights, the vault being hung

round,

round, during all this time, with wet linen cloths, to render the air as damp as poſſible, and the door of the vault being ſhut.

At the end of the three days I entered the vault with the balance, and weighed the various ſubſtances upon the ſpot, when they were found to weigh as is expreſſed in the third column of the following table.

The various ſubſtances.	Weight after being dried 24 hours in a hot room.	Weight after being expoſed 48 hours in a cold uninhabited room.	Weight after being expoſed 72 hours in a damp cellar.
	Parts.	Parts.	Parts.
Sheep's wool, - -	1000	1084	1163
Beaver's fur, - -	1000	1072	1125
The fur of a Ruſſian hare,	1000	1065	1115
Eider-down, - -	1000	1067	1112
Silk { raw, ſingle thread,	1000	1057	1107
Silk { ravelings of white taffety, - -	1000	1054	1103
Linen { fine lint, -	1000	1046	1102
Linen { ravelings of fine linen, -	1000	1044	1082
Cotton wool, - -	1000	1043	1089
Silver wire, very fine, gilt, and flatted, being the ravelings of gold lace, -	1000	1000	1000

N. B. The weight made uſe of in theſe experiments was that of Cologne, the *parts* or leaſt diviſions being $= \frac{1}{65536}$ part of a mark; conſequently 1000 of theſe *parts* make about $52\frac{3}{4}$ *grains troy.*

I did not add the ſilver wire to the bodies above mentioned from any idea that that ſubſtance could poſſibly imbibe moiſture from the atmoſphere; but I was willing to ſee whether a metal, placed in air ſaturated with water, is not capable of receiving a ſmall addition of weight from the moiſture attracted by it, and attached to its ſurface; from the reſult of the experiment, however, it ſhould ſeem that no ſuch attraction ſubſiſts between the metal I made uſe of and the watery vapour diſſolved in air.

I was totally miſtaken in my conjectures relative to the reſults of the experiments with the other ſubſtances. As linen is known to attract water with ſo much avidity, and as, on the contrary, wool, hair, feathers, and other like animal ſubſtances, are made wet with ſo much difficulty, I had little doubt but that linen would be found to attract moiſture from the atmoſphere with

much

much greater force than any of those substances; and that, under similar circumstances, it would be found to contain much more water; and I was much confirmed in this opinion upon recollecting the great difference in the apparent dampness of linen and of woollen cloths, when they are both exposed to the same atmosphere. But these experiments have convinced me that all my speculations were founded upon erroneous principles.

It should seem that those bodies which are the most easily wet, or which receive water in its unelastic form with the greatest ease, are not those which, in all cases, attract the watery vapour dissolved in the air with the greatest force.

Perhaps the apparent dampness of linen, to the touch, arises more from the ease with which that substance parts with the water which it contains, than from the quantity of water it actually holds; in the same manner as a body appears hot to the touch, in consequence of its parting freely with its heat; while another body which is actually at the same temperature, but which withholds its heat with greater obstinacy, affects the sense of feeling much less violently.

It is well known that woollen clothes, ſuch as flannels, &c. worn next the ſkin, greatly promote inſenſible perſpiration. May not this ariſe principally from the ſtrong attraction which ſubſiſts between wool and the watery vapour which is continually iſſuing from the human body?

That it does not depend entirely upon the warmth of that covering is clear; for, the ſame degree of warmth, produced by wearing more clothing of a different kind, does not produce the ſame effect.

The perſpiration of the human body, being abſorbed by a covering of flannel, is immediately diſtributed through the whole thickneſs of that ſubſtance, and by that means expoſed, by a very large ſurface, to be carried off by the atmoſphere; and the loſs of this watery vapour, which the flannel ſuſtains on the one ſide, by evaporation, being immediately reſtored from the other, in conſequence of the ſtrong attraction between the flannel and this vapour, the pores of the ſkin are diſincumbered, and are continually ſurrounded by a dry, warm, and ſalubrious, atmoſphere.

I am

I am astonished that the custom of wearing flannel next the skin should not have prevailed more universally. I am confident it would prevent a multitude of diseases; and I know of no greater luxury than the comfortable sensation which arises from wearing it, especially after one is a little accustomed to it.

It is a mistaken notion that it is too warm a clothing for summer. I have worn it in the hottest climates, and in all seasons of the year, and never found the least inconvenience from it. It is the warm-bath of a perspiration confined by a linen shirt, wet with sweat, which renders the summer-heats of southern climates so insupportable; but flannel promotes perspiration, and favours its evaporation; and evaporation, as is well known, produces positive cold. I first began to wear flannel, not from any knowledge which I had of its properties, but meerly upon the recommendation of a very able physician, (Sir Richard Jebb,) and, when I began the experiments of which I have here given an account, I little thought of discovering the physical cause of the good effects which I had experienced from

it;

it; nor had I the most distant idea of mentioning the circumstance. I shall be happy, however, if what I have said, or done, upon the subject, should induce others to make a trial of what I have so long experienced with the greatest advantage, and which, I am confident, they will find to contribute greatly to health, and consequently to all the other comforts and enjoyments of life.

I shall then think these experiments, trifling as they may appear, by far the most fortunate, and the most important ones I have ever made.

With regard to the original object of these experiments, the discovery of the relation which I thought might possibly subsist between the warmth of the substances in question, when made use of as clothing, and their powers of attracting moisture from the atmosphere, or, in other words, between the quantities of water they contain and their conducting powers with regard to heat, I could not find that these properties depended in any manner upon, or were in any way connected with, each other.

XXXIII.

XXXIII. *An Account of a Method of measuring the comparative Intensities of the Light emitted by luminous Bodies; by Lieutenant General Sir* Benjamin Thompson, *Count of Rumford, F.R.S.*

WITH THREE PLATES.

From the Transactions of the Royal Society of London.

About two years ago, being employed in making a number of experiments to determine, if possible, the most œconomical method of lighting up a very large workhouse, or public manufactory, which has been erected in the suburbs of this city, (Munich,) under my directions, where the poor, old and young, and all industrious people who are in want of work, are employed in a great variety of different manufactures, a method occurred to me for measuring the relative quantities of light emitted by lamps of different con-

conſtructions, candles, &c. which is very ſimple, and which I have reaſon to think perfectly accurate. The method is ſhortly this: let the two burning candles, lamps, or other lights, to be compared, A and B, be placed at equal heights upon two light tables, or movable ſtands, in a darkened room; let a ſheet of clean white paper be equally ſpread out, and faſtened upon the wainſcot, or ſide of the room, at the ſame height from the floor as the lights; and let the lights be placed over-againſt this ſheet of paper, at the diſtance of 6 or 8 feet from it, and 6 or 8 feet from each other, in ſuch a manner, that a line drawn from the centre of the paper, perpendicular to its ſurface, ſhall biſect the angle formed by lines drawn from the lights to that centre; in which caſe, conſidering the ſheet of paper as a plane ſpeculum, the one light will be preciſely in the line of reflection of the other.

This may be eaſily performed, by actually placing a piece of a looking-glaſs, 6 or 8 inches ſquare, flat upon the paper, in the middle of it; and obſerving, by means of it, the real lines of reflection of the lights from that plane, removing

it

it afterwards, as ſoon as the lights are properly arranged.

When this is done, a ſmall cylinder of wood, about $\frac{1}{4}$ of an inch in diameter, and 6 inches long, muſt be held in a vertical poſition, about 2 or 3 inches before the centre of the ſheet of paper, and in ſuch a manner, that the two ſhadows of the cylinder, correſponding to the two lights, may be diſtinctly ſeen upon the paper.

If theſe ſhadows ſhould be found to be of unequal denſities, which will almoſt always be the caſe, then that light whoſe correſponding ſhadow is the denſeſt muſt be removed farther off, or the other muſt be brought nearer to the paper, till the denſities of the ſhadows appear to be exactly equal; or, in other words, till the denſities of the rays from the two lights are equal *at the ſurface of the paper*; when, the diſtances of the lights from the centre of the paper being meaſured, the ſquares of thoſe diſtances will be to each other as the real intenſities of the lights in queſtion at their ſources.

If, for example, the weaker light being placed at the diſtance of four feet from the centre of the

 paper,

paper, it ſhould be found neceſſary, in order that the ſhadows may be of the ſame denſity, to remove the ſtronger light to the diſtance of 8 feet from that centre, in that caſe, the real intenſity of the ſtronger light will be to that of the weaker as 8^2 to 4^2; or as 64 to 16; or 4 to 1; and ſo for any other diſtances.

It is well known, that when any quality proceeds from a centre in ſtraight lines in all directions, like the light emitted by a luminous body, its intenſity at any given diſtance from that centre will be as the ſquare of that diſtance inverſely; and hence it is clear, that the intenſities of the lights in queſtion, at their ſources, muſt be to each other as the ſquares of their diſtances from that given point *where their rays uniting are found to be of equal denſity*. For, putting x = the intenſity of B, if P repreſents the point where the rays from A and from B meeting are found to be of equal denſity or ſtrength, and if the diſtance of A from P be $= m$, and the diſtance of B from the ſame point P $= n$; then, as the intenſity of the light of A at P is $= \frac{x}{m^2}$, and the intenſity of the

light

light of B at the ſame place $=\frac{y}{n}$, and as it is $\frac{x}{m^2}=\frac{y}{n^2}$ by the ſuppoſition, it will be $x:y::m^2:n^2$.

That the ſhadows being of equal denſity at any given point, the intenſities of the illuminating rays muſt of neceſſity be equal at that point alſo, is hence evident, that the total abſence of light being perfect blackneſs, and the ſhadow correſponding to one of the lights in queſtion being deeper or fainter, according as it is more or leſs enlightened by the other, when the ſhadows are equal the intenſities of the illuminating rays muſt be equal likewiſe.

In removing the lights, in order to bring the ſhadows to be of the ſame denſity, care muſt be taken to recede from, or advance towards, the centre of the paper, in a ſtraight line, ſo that the one light may always be found exactly in the line of reflection of the other; otherwiſe, the rays from the different lights falling upon the paper, and conſequently upon the ſhadows, at different angles, will render the experiment fallacious.

When the intenſity of one ſtrong light is compared with the intenſities of ſeveral ſmaller lights

 taken

taken together, the ſmaller lights ſhould be placed in a line perpendicular to a line drawn to the centre of the paper, and as near to each other as poſſible; and it is likewiſe neceſſary to place them at a greater diſtance from the paper than when only ſingle lights are compared.

In all caſes, it is abſolutely neceſſary to take the greateſt care that the lights compared be properly trimmed, and that they burn clear and equally, otherwiſe the reſult of the experiments will be extremely irregular and inconcluſive. It is aſtoniſhing what a difference there is in the quantities of light emitted by the ſame candle, when it burns with its greateſt brilliancy, and when it has grown dim for want of ſnuffing. But as this diminution of light is progreſſive, and as the eye inſenſibly conforms to the quantity of light actually preſent, it is not always taken notice of by the ſpectators; it is nevertheleſs very conſiderable in fact, as will be apparent to any one who will take the trouble to make the experiment; and ſo great is the fluctuation in the quantity of light emitted by burning bodies, lamps, or candles, in all caſes, even under the moſt favourable circumſtances,

ſtances, that this is the ſource of the greateſt difficulties I have met with, in determining the relative intenſities of lights by the method here propoſed.

To aſcertain by this method the comparative denſities, or intenſities, of the light of the moon and of that of a candle, the moon's direct rays muſt be received upon a plane white ſurface, at an angle of incidence of about 60°, and the candle placed in the line of the reflection of the moon's rays from this ſurface; when, the ſhadows of the cylinder, correſponding to the moon's light and to that of the candle, being brought to be of equal denſity, by removing the candle farther off, or bringing it nearer to the centre of the white plane, as the occaſion may require, the intenſity of the moon's light will be equal to that of the candle *at the given diſtance of the candle from the plane.*

To aſcertain the intenſity of the light of the heavens, by day or by night, this light muſt be let into a darkened room through a long tube blackened on the inſide, when its intenſity may be

be compared with that of a candle or lamp by the method above deſcribed.

To determine the intenſity of the direct rays of the ſun, compared to the light emitted by any of our artificial illuminators, it may perhaps be neceſſary, conſidering the almoſt inconceivable intenſity of the ſun's light, to make uſe of ſome farther contrivances and precautions; I am convinced, however, that it may be done, and that even with a very conſiderable degree of preciſion. And, when the relative intenſity of the ſun's light at the ſurface of the earth, compared with the intenſity of the light of a given lamp, placed at a given diſtance, and burning with a flame of given dimenſions, ſhall be known, it will then be eaſy, from the known ſize and diſtance of the ſun, to compute the relative denſity of his light at *his* ſurface, compared to the denſity of the light of the flame of the lamp at the ſurface of that flame.

The intenſity of the light emitted in the combuſtion of iron, or of phoſphorus, in dephlogiſticated air, as alſo that of all other burning or red-

red-hot bodies, may be compared and determined by this method, with the greateſt facility and exactneſs.

Since the above was written I have made many improvements in the apparatus contrived for meaſuring the intenſity of light, and I have now brought the principal inſtrument to ſuch a degree of perfection, that, if I might without being ſuſpected of affectation, I ſhould dignify it with a name, and call it a *photometer*. I have likewiſe made a conſiderable number of new experiments; but, before I proceed to give an account of them, it will be neceſſary to deſcribe very particularly the alterations I have found it expedient to make in the inſtruments.

In the firſt place, the ſhadows, inſtead of being thrown upon a paper ſpread out upon the wainſcot or ſide of the room, are now projected upon the inſide of the back part of a wooden box, 7 ¼ inches wide, 10 ½ inches long, and 3 ¼ inches deep, in the clear, open in front to receive the

light,

light, and painted black on the inſide, in every part, except the back, upon which the white paper is faſtened which receives the ſhadows. To the under part of the box is fitted a ball and ſocket, by which it is attached to a ſtand which ſupports it; and the top or lid of it is fitted with hinges, in order that the box may be laid quite open, as often as it is neceſſary to alter any part of the machinery it contains. The front of the box is likewiſe furniſhed with a falling lid or door, moveable upon hinges, by which the box is cloſed in front when it is not in actual uſe.

I had found it very inconvenient to compare two ſhadows projected by the ſame cylinder, as theſe were either neceſſarily too far from each other to be compared with certainty, or, when they were nearer, were in part hid from the eye by the cylinder; to remedy this inconvenience, I now make uſe of two cylinders, which are fixed perpendicularly in the bottom of the box juſt deſcribed, in a line parallel to the back part of it, diſtant from this back $2\frac{2}{10}$ inches, and from each other 3 inches, meaſuring from the centres of the cylinders; when the two lights made uſe of in the

the experiment are properly placed, theſe two cylinders project four ſhadows upon the white paper upon the inſide of the back part of the box, which I ſhall henceforth call the *field* of the inſtrument; two of which ſhadows are in contact, preciſely in the middle of that field, and it is theſe two alone that are to be attended to. To prevent the attention being diſtracted by the preſence of unneceſſary objects, the two outſide ſhadows are made to diſappear; which is done by rendering the field of the inſtrument ſo narrow, that they fall without it, upon a blackened ſurface, upon which they are not viſible. If the cylinders be each $\frac{4}{10}$ of an inch in diameter, and $2\frac{2}{10}$ inches in height, as in the inſtrument I have lately conſtructed, it will be quite ſufficient that the field be $2\frac{7}{10}$ inches wide; and, as an unneceſſary height of the field is not only uſeleſs, but diſadvantageous, as a large ſurface of white paper not covered by the ſhadows produces too ſtrong a glare of light, the field ought not to be more than $\frac{3}{10}$ of an inch higher than the tops of the cylinders.

In order to be able to place the lights with facility and preciſion, a fine black line is drawn

through the middle of the field, from the top to the bottom of it, and another (horizontal) line at right angles to it, at the height of the top of the cylinders. When the tops of the ſhadows touch this laſt-mentioned line, the lights are at a proper height; and farther, when the two ſhadows are in contact with each other in the middle of the field, the lights are then in their proper directions.

In my new-improved inſtrument, (for I have already cauſed four to be conſtructed,) the white paper which forms the field is not faſtened immediately upon the inſide of the back of the box, but is paſted upon a ſmall pane of very fine ground glaſs; and this glaſs, thus covered, is let down into a groove, made to receive it, in the back of the box. This covered glaſs is 5½ inches long, and as wide as the box is deep, *viz.* 3¼ inches; but the field of the inſtrument is reduced to its proper ſize by a ſcreen of black paſteboard, interpoſed before the anterior ſurface of this covered glaſs, and reſting immediately upon it. A hole in this paſteboard, in the form of an oblong ſquare, $1\frac{7}{10}$ inch wide, and two inches high, determines the dimenſions,

dimenſions, and forms the boundaries, of the field. This ſcreen ſhould be large enough to cover the whole inſide of the back of the box, and it may be fixed in its place by means of grooves in the ſides of the box, into which it may be made to enter. The poſition of the opening above-mentioned is determined by the height of the cylinders; the top of it being $\frac{3}{10}$ of an inch higher than the tops of the cylinders; and, as the height of it is only two inches, while the height of the cylinders is $2\frac{2}{10}$ inches, it is evident that the ſhadows of the lower parts of the cylinders do not enter the field. No inconvenience ariſes from that circumſtance; on the contrary, ſeveral advantages are derived from that arrangement.

Inſtead of the ſcreen juſt deſcribed, I ſometimes make uſe of another, which differs from it only in this, that the hole in it, which determines the form and dimenſions of the field, inſtead of being quadrangular, is round, and $1\frac{6}{10}$ inch in diameter. And, when this ſcreen is made uſe of, the ſhadows are increaſed in width, (by means which will hereafter be deſcribed,) in ſuch a man-

ner as completely to fill the field, appearing under the form of two hemifpheres, or rather half-difks, touching each other in a vertical line. The object I had in view in reducing the field, and the fhadows, to a circular form was this: I imagined that, by diminifhing the number of objects capable of acting upon the mind, and particularly by removing all ftraight lines and angles, and all unneceffary varieties of lights and fhades, the attention might be concentrated and fixed, in fuch a manner as to render the fenfe of fight peculiarly acute in diftinguifhing any difference in the fimple objects prefented to the eye. But, however plaufible this reafoning may appear, I own the experiment did not anfwer my expectation. It is true, the apparent denfities of two equal hemifpheres of fhade, in contact with each other, may be compared with great facility; and, when no difcernible difference is to be perceived between them, it is more than probable that they are in fact very nearly equal; but ftill I have found, by experience, that two equal parallelograms of fhade, in contact with each other, may be compared with the fame eafe, and, I have reafon to think, with

equal

equal certainty, and *that* even when theſe united ſhadows are bounded on three ſides by a perfectly white ſurface, illuminated by the direct rays of two ſtrong lights; that is to ſay, when the ſcreen with the quadrangular opening or field is made uſe of.

In deſcribing the cylinders by which the ſhadows are projected, I ſaid they were fixed in the bottom of the box; but, as the diameters of the ſhadows of the cylinders vary in ſome ſmall degree, in proportion as the lights are broader or narrower, and as they are brought nearer to, or removed farther from, the *photometer*, in order to be able in all caſes to bring theſe ſhadows to be of the ſame diameter, which I have found, by experience, to be advantageous, in order to judge with greater facility and certainty when the ſhadows are of the ſame denſity, I have rendered the cylinders movable about their axes, and have added to each a vertical wing, $\frac{11}{20}$ of an inch wide, $\frac{1}{10}$ of an inch thick, and of equal height with the cylinder itſelf, and firmly fixed to it from the top to the bottom. This wing commonly lies in the middle of the ſhadow of the cylinder, and as long

as

as it remains in that ſituation it has no effect whatever; but, when it is neceſſary that the diameter of one of the ſhadows be increaſed, the correſponding cylinder is moved about its axis, till the wing juſt deſcribed, emerging out of the ſhadow, and intercepting a portion of light, brings the ſhadow projected upon the field of the inſtrument to be of the width or diameter required. In this operation, it is always neceſſary to turn the cylinder outwards, or in ſuch a manner that the augmentation of the width of the ſhadow may take place on that ſide of it which is oppoſite to the ſhadow correſponding to the other light. The neceſſity for that precaution will appear evident to any one who has a juſt idea of the inſtrument in queſtion, and of the manner of making uſe of it.

It is by means of theſe wings attached to the cylinders that the widths of the ſhadows are augmented, ſo as to fill the whole field of the *photometer*, when the ſcreen with the circular opening is made uſe of.

TO BE CONTINUED IN OUR NEXT.

XXXIV. *Conclusion of Mr.* GADOLIN's *Experiments on the Purification of crude Saltpetre, by Means of Charcoal-powder.*

(FROM P. 216.)

G. SIX *lods* of mother-water, mixed with eight *lods* of water, and one *lod* and a half of charcoal-powder, were put over a moderate fire, where they were kept boiling for the space of ten minutes, after which I poured the liquor into a filter, through which I made it pass with twelve *lods* of boiling water. The filtered liquor was transparent, and of a light yellow colour. I mixed it again with one *lod* and a half of charcoal-powder; boiled it as before, and filtered it. It passed much more readily through the filter than the first time; and was almost as colourless as plain water, having only a very light yellowish tinge. I again boiled this lie, the volume of which was equal to fourteen

fourteen ounces of water, upon a moderate fire, and reduced it to the volume of one ounce; after which I ſet it in a cold place. In a few minutes it was full of white cubical cryſtals of *ſal digeſtivum*, amongſt which there formed, after a longer cooling, a quantity of priſmatic cryſtals of ſaltpetre: the two quantities together weighed 0,9 of a *lod*. The remaining lie gave me, by a farther evaporation, 0,17 of a *lod* of cubical cryſtals. Theſe cryſtalized ſalts emitted a ſmell of muriatic acid, upon being held over the fire; and, when I diſſolved them again in water, they left a ſmall quantity of powder undiſſolved. I threw ſome vegetable alkali into the ſolution; it occaſioned a precipitate of a light grey colour, which weighed 0,06 of a *lod*. The lie remaining after all, when no more cryſtals could be procured, gave a precipitate which weighed 0,119 of a *lod*, and which conſiſted of calcareous earth and magneſia.

The charcoal-powder which was made uſe of had gained in weight about half a *lod*.

VI. From the experiments of the preceding ſection, which I made in order to diſcover the

conſtituent

conſtituent parts of my crude ſaltpetre, it follows, that 100 parts of that ſaltpetre contain about $9\frac{1}{2}$ parts of mother-water; (A;) alſo, that they contain about $\frac{3}{7}$ more of muriatic acid than is contained in a correſponding quantity of mother-water; for, according to experiment B, 100 parts of crude ſaltpetre contained as much muriatic acid as is found in 4,96 parts of *luna cornea*; but, according to experiment D, the muriatic acid in nine parts and a half of mother-water correſponds only to 3,5 parts of *luna cornea*. This proportion, however, may require ſome correction; particularly when it is conſidered that the greaſy matter, which is abſorbed in the precipitation of the metallic calx, augments the weight of the precipitate; this is evident from the experiment with a ſolution of mercury, (F.) But, with reſpect to the foulneſs, which could not be great, in proportion to the whole precipitation of ſilver, I think it the leſs neceſſary to conſider it here, as I obſerved, on the contrary, that my *luna cornea* appeared more ſoluble in water (and conſequently was more diminiſhed in quantity during the draining and filtering) than a pure *luna cornea* generally is.

This probably was occaſioned by the volatile alkali which was contained in the mother-water; which is capable of diſſolving ſilver, when that metal is united to marine acid.

VII. From experiment G I draw the following inference, namely, that 100 parts of the mother-water contained about 8,5 parts of greaſy matter, which was abſorbed by the charcoal; now, as the whole of the ſubſtances contained in the mother-water, after the diſſolution, amounted to 31 parts in 100, according to experiment F, it follows alſo, that the ſalts contained in the mother-water (which were principally formed of marine acid united to vegetable alkali, calcareous earth, and magneſia) amounted to 22,5 parts in 100.

Therefore the conſtituent parts of the crude ſaltpetre I examined may be conſidered as, very nearly, eighty-nine parts and a half of pure ſaltpetre, three parts of neutral ſalts of the nature of ſea-ſalt, one part of greaſy matter, and ſix parts and a half of water, beſides the water of cryſtalization.

VIII. As experiment G proves that the mother-water may be deprived of the greaſy matter, by

means of charcoal-powder, I had no doubt that the ſame thing would happen to crude ſaltpetre, if treated in the ſame manner. But what proportion of charcoal would be neceſſary for a given quantity of ſaltpetre, and what remarkable phænomena might reſult from ſuch an operation, were circumſtances I wiſhed to inform myſelf of.

The following is the manner in which I proceeded in making the four experiments hereafter deſcribed.

I firſt threw a pound of crude ſaltpetre, with the charcoal-powder, and ſix pounds of pure water, into a copper veſſel. I kept the whole boiling upon the fire for the ſpace of ten minutes, and then filtered the decoction through a double filtering-paper. I afterwards paſſed through the filter two pounds of boiling water, and then evaporated, by boiling, the whole of what had paſſed through the filter, till a drop of it, thrown upon a cold piece of glaſs, immediately ſhewed ſigns of cryſtalization, and was in a few ſeconds converted into cryſtals.

I then poured the whole of the lie into a glaſs veſſel, which I placed, uncovered, in a cold place,

that the ſalt might cryſtalize. In this way I obtained, from the firſt cryſtalization, about twenty *lods* of ſaltpetre. The remaining lie was then again evaporated, till the ſame diſpoſition to cryſtalization appeared as before: I obtained from it about ſix *lods* and a half of ſaltpetre. After a third evaporation, I obtained two *lods* more. What then remained of the lie produced a ſmall quantity of ſaltpetre, mixed with a great deal of *ſal digeſtivum.*

Firſt Experiment.

After having boiled one pound of crude ſaltpetre with eight *lods* of charcoal-powder, in the manner already mentioned, the lie appeared quite as clear as water, and the cryſtals I obtained from the firſt and ſecond evaporation were perfectly white and clear. Half a *lod* of each cryſtalization, being diſſolved in three *lods* and a half of water, acquired a milky appearance from a ſolution of ſilver in nitrous acid; and each of the ſolutions gave me a quantity of precipitate, weighing 0,002 parts of a *lod*.

After

After the third evaporation, the cryſtals I obtained were ſtill very clear, and evidently whiter than good common ſaltpetre. Half a *lod* of them, by means of a ſolution of ſilver, gave a precipitate which weighed 0,007 parts of a *lod.*

The cryſtals of mixed ſalts which I obtained from the fourth evaporation were ſtill very white, but leſs clear than the preceding.

The laſt remaining part of the mother-water was become a little yellowiſh; but, I procured from it, by means of vegetable alkali, a white precipitate, weighing about one tenth of a *lod,* which conſiſted of magneſia and calcareous earth.

Second Experiment.

From one pound of crude ſaltpetre, boiled with four *lods* of charcoal-powder, I procured a clear lie with a yellowiſh tinge. The cryſtals formed after a firſt, ſecond, and third, evaporation could not, by any means, be diſtinguiſhed from thoſe which I obtained in the firſt experiment. They were alſo affected nearly in the ſame manner by a ſolution of ſilver; for, half a *lod* of the firſt cryſ-

talization

talization gave me 0,002 parts of *luna cornea*, ſo alſo did half a *lod* of the ſecond. Half a *lod* of the third cryſtalization gave me 0,008 parts of a *lod* of *luna cornea*. What I obtained from the fourth cryſtalization had a yellowiſh tinge; and the mother-water then remaining was of a reddiſh yellow colour.

Third Experiment.

One pound of crude ſaltpetre, with two *lods* of charcoal-powder, produced a yellowiſh lie, from which I obtained, by the firſt cryſtalization, very white and clear cryſtals; nevertheleſs, when I examined them more clearly, and compared them with the cryſtals obtained from the firſt cryſtalization in the preceding experiments, I obſerved that they appeared to have a yellowiſh tinge. From half a *lod* of theſe cryſtals, by means of a ſolution of ſilver, I obtained 0,0006 parts of a *lod* of *luna cornea*. The cryſtals produced by a ſecond cryſtalization were ſimilar, in appearance, to thoſe of the firſt; and half a *lod* of them gave me, with a ſolution of ſilver, 0,0006 parts of a *lod* of *luna cornea*. The cryſtals I obtained from a

third

third cryſtalization were evidently more yellow, like thoſe of ſaltpetre purified by the uſual proceſſes. Half a *lod* of theſe cryſtals gave me, with a ſolution of ſilver, 0,012 parts of a *lod* of *luna cornea*. Fróm the fourth cryſtalization I obtained cryſtals of a bright yellow; the remaining lie had a dark brown yellow colour.

Fourth Experiment.

One pound of crude ſaltpetre, with one *lod* of charcoal-powder, produced a lie of a dark reddiſh yellow colour; from which I procured, at the firſt cryſtalization, cryſtals of ſaltpetre which were ſufficiently white, but leſs clear than thoſe of the foregoing experiments. Half a *lod* of theſe cryſtals, diſſolved in three *lods* and a half of water, produced a lie which, upon my pouring into it ſome of the ſolution of ſilver, became milky, but no precipitate was formed; being filtered, the lie again became clear, but the matter which remained behind upon the filter was not ſenſible in my ſcales, and could not exceed the 0,0001 part of a *lod*. The cryſtals which I obtained from a ſecond

a ſecond cryſtalization were ſimilar to thoſe which the preceding experiment gave me at the third. From half a *lod* of them, by means of a ſolution of ſilver, I procured 0,0034 parts of a *lod* of *luna cornea.* The cryſtals I got from a third cryſtalization were yellowiſh; half a *lod* of them gave me, with a ſolution of ſilver, 0,0135 parts of a *lod* of precipitate. The lie which remained was of a dark brown colour.

Fifth Experiment.

In order to eſtabliſh a compariſon with the preceding experiments, I diſſolved one pound of crude ſaltpetre in ſix pounds of water, and I kept it boiling as before, but without adding any charcoal-powder. The filtered lie was of a dark brown colour. The ſaltpetre which I obtained at the firſt cryſtalization was rather of a yellowiſh colour, and reſembled the cryſtals of the third cryſtalization in the third experiment. Half a *lod* of it gave me, by means of a ſolution of ſilver, 0,001 part of a *lod* of *luna cornea.* That which I obtained from a ſecond cryſtalization was more

yellow;

yellow; half a *lod* of it gave me, by means of a ſolution of ſilver, 0,0045 parts of a *lod* of *luna cornea.* From a third cryſtalization I obtained cryſtals of a ſtill deeper yellow, half a *lod* of which gave me, with a ſolution of ſilver, 0,017 parts of a *lod* of precipitate of ſilver. The remaining lie was of a blackiſh brown colour.

IX. It is remarkable that the ſaltpetre which was obtained (at the firſt cryſtalization) from the lies which were completely deprived of the greaſy matter ſhewed, by means of a ſolution of ſilver, a greater proportion of marine acid than that which ſtill contained a certain quantity of that matter. This is perhaps owing (unleſs the greaſy matter renders the precipitate of ſilver more ſoluble in water) to the ſaltpetre being more diſpoſed to cryſtalize when the lie is pure; a circumſtance which prevents it from ſeparating ſo completely from the particles of ſea-ſalt, or other ſalts of that nature; as, on the other hand, theſe particles inſinuate themſelves in greater proportion, when the lie is much charged with greaſy matter, which, by its viſcoſity, much obſtructs a regular cryſtalization.

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But theſe inconveniences, ariſing from a laboured mode of purification, need not perhaps be feared in operations on a large ſcale; where the cooling takes place more ſlowly, and the cryſtalization is always more regular. For, that greater proportion of ſea-ſalt which is found in ſaltpetre produced from a more pure lie, and which is obſerved only when a ſmall quantity of that ſalt is found in the lie, does not exceed $\frac{1}{6}$ *per cent.* of the weight of the ſaltpetre. It is probable that a quantity of ſea-ſalt ſo very inconſiderable muſt be of leſs injury, in the proceſs of making gunpowder, than the ſmalleſt foulneſs produced by the greaſy matter.

On the contrary, there is an undoubted advantage in ſeparating completely the greaſy matter, even with reſpect to the proportion of ſea-ſalt, when that ſalt is found in great quantity in the lie.

For, when the lie was found to contain, in the ſecond cryſtalization, about ten to twelve *per cent.* (with reſpect to the ſaltpetre) of ſea-ſalt, or ſalts ſimilar to it, it was only in thoſe caſes in which the greaſy matter was entirely taken away, that

the cryſtals which were formed contained a quantity of marine acid correſponding to $\frac{1}{5}$ *per cent.* of ſea-ſalt. But, when a ſmaller quantity of charcoal, or none at all, was made uſe of, the proportion of ſea-ſalt amounted to $\frac{1}{4}$ and $\frac{3}{8}$ *per cent.* And when, at the third cryſtalization, the lie was found to contain nearly 30 *per cent.* of ſea-ſalt, the ſaltpetre, well purified by the charcoal, contained no more than $\frac{2}{3}$ *per cent.* of ſea-ſalt; whereas that which had been made without charcoal contained more than double that quantity, or $1\frac{1}{2}$ *per cent.*

X. I concluded, from the foregoing experiments, that two *lods* and a half of charcoal-powder were ſufficient to ſeparate from the lie ſo much greaſy matter, that the cryſtals ſhould be completely purified at the firſt cryſtalization.

Upon that principle I undertook another ſeries of experiments, with the remaining part of my crude ſaltpetre; proceeding in the following manner.

I boiled one pound of crude ſaltpetre, with two *lods* and a half of charcoal-powder, and ſix pounds of water, for the ſpace of ten minutes, and filter-

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ed the lie. I then paſſed two pounds of boiling water over the charcoal, and evaporated the whole of what had paſſed through the filter, till it ſhewed the diſpoſition to cryſtalization before deſcribed; I then let it cryſtalize.

The clear lie which remained was poured off from the cryſtals, and mixed with twenty-four *lods* of crude ſaltpetre, and two *lods* and a half of charcoal-powder; it was then boiled as before.

I repeated this experiment ſeveral times, as is ſhewn in the following table, and, at every cryſtalization, very white and clear cryſtals of ſaltpetre were obtained.

In the firſt column of the table is ſet down the weight of crude ſaltpetre which I uſed in each boiling. In the ſecond, the weight of the charcoal added to it. In the third, the weight of the cryſtals of ſaltpetre obtained. In the fourth, the weight of the precipitate produced, by means of a ſolution of ſilver, from half a lod of cryſtalized ſaltpetre. In the fifth, the precipitate of ſilver obtained from the cryſtals, computed *per cent.* with reſpect to the ſaltpetre. In the ſixth, the precipitate of ſilver obtained from the crude ſalt-

petre

petre in the lie, computed, as near as could be, (according to experiment B, Sect. 5,) *per cent.* with reſpect to pure and diſſolved ſaltpetre.

Experiment	Weight of the crude ſaltpetre.	Weight of the charcoal.	Weight of the cryſtallized ſaltpetre.	Precipitate of ſilver from half a *lod* of ſaltpetre.	Precipitate of ſilver from 100 parts of ſaltpetre.	Precipitate of ſilver, from the lie, to 100 parts of diſſolved ſaltpetre.
	Lods.	Lods.	Lods.	Lods.	Parts.	Parts.
1	32	2,5	19,5	0,0009	0,18	5,5
2	24	2,5	21,	0,0011	0,22	9
3	24	2,5	20,9	0,0013	0,26	13
4	24	2,5	20,4	0,0017	0,34	16
5	24	2,5	22,5	0,0025	0,50	20
6	24	2,5	20,	0,0018	0,36	24
7	24	2,5	21,5	0,0020	0,40	27
8	0	1,	6,7	0,0070	1,4	90
9	0	0,	2,5	0, 179	35,8	300

Before

Before the ſaltpetre of No. 9 cryſtalized, there was formed on the lie a thick cruſt of ſalt; I therefore let it cool, and there ſoon appeared a quantity of cubical cryſtals. The remaining lie gave me alſo (as is ſeen in the table) two *lods* and a half of ſaltpetre, mixed with ſea-ſalt.

I diſſolved the forementioned cruſt, and the cubical cryſtals, in water; there was left a certain quantity of white powder which would not diſſolve, and which appeared to be of a gypſeous nature: it weighed 0,06 of a *lod*. From this ſolution and the laſt remaining mother-water I obtained, by means of vegetable alkali, a light-coloured precipitate which weighed three-quarters of a *lod*; and which, beſides a little greaſy matter, conſiſted of calcareous earth and magneſia.

XI. From the experiments deſcribed in the preceding ſection, it evidently appears how little ſea-ſalt, or other ſalts which contain marine acid, are diſpoſed to cryſtalize with ſaltpetre, even when the lie has been deprived of greaſy matter, and cryſtalization conducted with attention.

But I ſhall not make any farther obſervations on theſe experiments, my deſign having been merely

merely to ſhew, that charcoal is an excellent medium for depriving crude ſaltpetre of its greaſy matter; and that, by its aſſiſtance, we may not only obtain ſaltpetre perfectly pure at the firſt cryſtalization, but may alſo advantageouſly employ the lie which is poured off from the cryſtals, as an addition to the following cryſtalizations.

Beſides, as the mother-water, according to experiment G, (Sect. 5.) may alſo be rendered fit for cryſtalization by means of charcoal-powder, there can be no reaſon why ſaltpetre-makers may not, with good effect, add this powder to their crude lie, when they boil it.

XII. But all operations in the large way require different combinations, and a different manner of proceeding, from thoſe experiments which are made with ſmall quantities. On that account, I cannot pretend to determine exactly how much charcoal may be neceſſary to purify any given large quantity of ſaltpetre: in all probability much leſs than two *lods* and a half to a pound of ſaltpetre would be ſufficient to produce all the advantage that can be deſired. We muſt therefore have recourſe to farther experience, to learn

the neceffary practical facts, and determine the manner of operating in a fure manner. As, in operations in the large way, the greafy matter appears in form of a fcum, we might take away the charcoal at the fame time with the fcum, and thus feparate them, both together, from the lie. In this way, filtration would not be neceffary; and the expence of this mode of purification would be very inconfiderable; but, if filtration fhould be found neceffary for operations in the large way, I ftill think that the expence would be amply compenfated by the fhortening of the tedious proceffes hitherto employed, and by the advantage of obtaining a more pure faltpetre than is ufually to be had, and which would certainly make gunpowder of a fuperior quality to that now made ufe of.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXIII.

XXXV. *Specification of the Patent granted to* Robert Murray, *of Lower Groſvenor-Place, in the Pariſh of Saint George, Hanover Square, Eſq. for his Diſcovery for refining Sugar, and making Sugar from the Cane-Juice.*

Dated Auguſt 20, 1784.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, I the ſaid Robert Murray do hereby declare, that my ſaid diſcovery for the refining of ſugar, and the making of ſugar from the cane-

juice, and by means of which Mufcavado or brown fugar may be made to yield a confiderably greater proportion of refined fugar, and better in quality, than can be obtained by the method ufually practifed, is defcribed in the manner following; that is to fay,

The improved procefs of making fugar from the cane-juice. The juice from the mills is immediately run through linen, into two or three copper caldrons, hereafter defcribed, and care is taken that the quantity in each caldron is fuch as fills it to twelve or thirteen inches only above the bottom; in which fituation it is quickly brought to a ftate of ebullition, for the purpofe of evaporating a part of the water, and condenfing and contracting the mafs. While it is boiling, a refufe matter prefents itfelf on the furface, as a black fcum, which muft be removed with a fkimmer. When it is contracted till the liquor is become thick, and when, by introducing the fkimmer, the latter drops which fall therefrom form fmall fheets, you muft empty your caldrons, previoufly putting out, or fuppreffing, the fires which were under them.

The

The liquor, in this ſtate, is taken from the two or three caldrons, and poured through a ſtrainer, hereafter deſcribed, into one or more caldrons, called boilers, which are filled about nine inches deep; there it is again brought to a ſtate of ebullition, and the evaporation is continued until it be ready to cryſtalize in large diſtinct grains. When the maſs is in this ſtate, you take it from the boiler, having firſt covered or extinguiſhed the fire, and put it into a cooler, hereafter deſcribed, in which it is frequently ſtirred by a wooden ſpatula, to accelerate cryſtalization, which will be completed by this means in more or leſs time, according as the maſs is poorer or richer. When the cryſtalization is complete, you take the maſs and place it in a draining trough, hereafter deſcribed, which is ſupported by two treſtles; under the trough is placed a cooler, ſimilar to the above mentioned, and which ſerves as a recipient for the ſyrup; which, oozing from the ſugar, and filtering itſelf through the apertures at the bottom of the trough, falls into this recipient, leaving in the trough the cryſtalized maſs, which

 muſt

muſt be left to drain well. You then put it into hogſheads, in which it is to be brought to Europe, when you mean to diſpatch it as raw ſugar. If you mean to clay it, then follow the proceſs for purification, or claying, of raw ſugar, as deſcribed in the proceſs of refining. The ſyrup which has fallen into the recipient is again put into a caldron, called the evaporating caldron; there it is evaporated afreſh, and brought to the ſame degree of conſiſtence with the cane-juice: when brought to this ſtate, it is placed in a cooler, ſuch as has been already mentioned, until it ſhall become cryſtalized; it is then put into a trough to drain, as has been already deſcribed. The ſyrup then ſeparates, and precipitates itſelf, as in the firſt proceſs, and the ſugar, well drained, is removed into hogſheads. The ſyrup which has oozed from this ſecond proceſs is again evaporated, and treated in every reſpect as the former, until the maſs is entirely exhauſted of cryſtaline particles. N. B. If any animal lymph can be procured, (and whites of eggs are preferable to any other,) an admixture thereof, in the caldron, will aſſiſt in getting

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rid of the extractive part, and render the raw ſugars moſt beautiful.

The caldrons. They are all of copper, and of the ſame form; the bottom, which is flat, is from ſixty to ſixty-ſix inches diameter within. The bottom ought to weigh from four hundred and eighty to five hundred pounds weight; they muſt be hammered cold, and well ſmoothed; the greateſt thickneſs to be in the middle; the elevation to be only one ſixth part of an inch. The circumference of the caldron muſt be made of three ſheets of copper, nailed to the bottom, brazed together, and ſoldered with ſtrong ſolder: the height of the firſt circumference is from ſixteen to ſeventeen inches, and each ſheet ought to weigh from fifty-five to ſixty pounds; of courſe, the three ſheets from one hundred and ſixty-five to one hundred and eighty pounds. At ſeventeen inches from the bottom of the caldron, the ſheets of copper are turned down horizontally about two inches, and raiſed again perpendicularly, in this form ; on the border a ſecond elevation of ſixteen inches is to be joined, but this laſt is diſcontinued or wanting at the front of the caldron,

where

where an aperture is left, of four feet ſix inches, to admit of a brace: the caldron is encircled with an iron hoop at the top. Each caldron ſhould be built on a ſeparate furnace, and have its proper fire, whether its fuel is to be of traſh, wood, or coals; the whole circumference of the caldron ought to be built up, as well as ſix inches of the bottom all round the edge of it, to the end that the fire may be reduced to forty-eight or fifty-four inches, according to the diameter of the caldron, and that neither flame nor heat ſhall circulate round the ſides of the caldron, as the fire muſt only operate on its bottom. The front of the furnace, and all that ſurrounds the caldron, ſhould be covered with lead.

The coolers. Theſe are made of wood, five feet ſquare, with an elevation of eight inches, and muſt be lined with ſheets of a pure white metal, which is, or ought to be, ſimilar to Smith's patent metal: theſe ſheets are ſoldered together, or folded into grooves, and turned down over the edges of the wooden caſe.

The draining troughs. A trough of wood, four feet long, three feet wide, and one foot high; at the

the bottom of which, lengthways, are three traverſe pieces of wood, exactly fitted to the trough; theſe ought to be of the form of the ariſs rail in the inſide of the trough, round which, on a level with the traverſe, is an abutment projecting about an inch. On the traverſes is placed an oſier hurdle, which forms the bottom of the trough, and is ſupported at the extremities by the abutment; this bottom is not fixed, but may be removed at pleaſure.

The ſtrainer. Theſe ſtrainers are of woollen, fixed on the ſurface of a wicker-work baſket, in the form of an oblong ſquare, by means of iron hooks, through which the liquor is to be poured.

The improved proceſs for refining raw ſugar. The baſis of this proceſs, and what eſſentially diſtinguiſhes it from the one now purſued, is the preliminary of waſhing the raw ſugar. The refiners at preſent diſſolve it in the ſtate in which it arrives from the colonies; by this new proceſs it never is diſſolved without being previouſly ſtripped of the ſubſtance which diſcolours it; this ſubſtance is an oily matter, which oppoſes the cryſtalization of a conſiderable portion of ſugar, as well as robs it

of

of its whitenefs. To feparate this matter, the raw fugar is put into cafes or boxes, hereafter defcribed, to the height of about eighteen inches; there, after having been well levelled, without any manner of compreffion, it is covered with a white clay, ftrongly triturated with water, and brought to the confiftence of a thick pap; this, which is the firft coat or covering, fhould be laid on about three quarters of an inch thick; when the water contained in this coat is infiltered into the mafs of fugar, the dry clay is removed from the furface, and a fecond coat or covering of the fame clay, about an inch thick, is applied. As foon as the white clay begins to retreat, and crack upon the furface, from one hundred to one hundred and fix degrees of heat, by Fahrenheit's thermometer, are introduced into the warehoufe; this heat gives a fluidity to the diffolution (caufed by the water) of that fubftance which colours the fugar; this folution infilters itfelf through the mafs, and precipitates itfelf, through the apertures at the bottom of the cafe, into a recipient placed below it; which recipient is exactly the fame as the coolers already defcri-

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bed in the procefs for boiling the cane-juice, only that the coolers for refining are two inches larger in the fquare. The clay which remains on the fugar is taken off when dry, and the heat is continued till the draining ceafes; then the purified or bleached fugar is taken from the cafe, of which a greater or lefs quantity will be obtained, according to the quality of the raw fugar; if it was good in quality, there will remain only four or five inches not purified. Thefe remains are collected to fill the cafes afrefh, of which near four fifths remain empty by the removal of the purged fugar; when they are filled again, the procefs of claying is performed precifely as above defcribed. The drainings which are produced by this purification furnifh an abundant cryftalization in the recipient; this cryftalization is fpontaneous. When, by repeated purifications, the recipient becomes three quarters full, it is emptied into draining troughs; (already defcribed in the procefs of raw fugars;) all that which is cryftalized remains in the trough, that which is not precipitates itfelf through the hurdle; this is a black, thick, and bitter melaffes, and is no longer fufceptible of

cryſtalization, from it however we may extract, by means of fermentation, a quantity of ſpirit fit for varniſhing, but which is diſagreeable to the palate if drunk. The raw ſugar, clayed, purged, or purified, by this proceſs, is then in a proper ſtate to be refined; for this end it muſt be clarified: this operation nearly reſembles that which is commonly practiſed by the refiners, it differs only in not making uſe of lime-water to diſſolve the ſugar, according to the uſual proceſs, but of common pond or river water; and, in clarifying with whites of eggs, in place of uſing bullock's blood, which is the practice of the preſent refiners. The caldrons to clarify reſemble thoſe which are deſcribed in the proceſs of working up the cane-juice; only adding a copper plate which ſhuts up the aperture left in the front of the caldron, at the ſecond elevation, and enables the ſugar-boiler to fill up the caldron to the uppermoſt brim. The clarification effected, the ſugar is deprived of thoſe heterogeneous particles which ſoiled it, we therefore proceed to the evaporation of the fluid; to effect this, the clarified or pure maſs is put into boilers, (*vide* the boilers deſcri-

bed

bed for the cane-juice,) not above eight or nine inches deep, till it arrives at that degree of contraction known by the term of *point of proof* in the refineries; that is to ſay, that ſtate of contraction which occaſions the maſs to cryſtalize as it cools, and to become a ſolid body, taking the form of thoſe moulds into which it is caſt, and ſeparating therefrom in an intire body when completely cold; the ſtate of contraction ought to be ſuch as ſuffices for this purpoſe, but ſhould never be carried beyond it. The ſugar, being put into moulds, is treated in the ſame manner as in the common refineries, *viz.* it is therein divided, and moved, while cooling; and, when cold, the mould is placed on a pot or recipient, into which the firſt oozing runs; afterwards it is clayed till the loaf becomes univerſally of an equal degree of whiteneſs. There remains then to work up the ſugar which has been accidentally carried away with the ſcum, the unclouded ſyrup, (or that which oozes ſpontaneouſly,) and the cloudy ſyrup, (or that which oozes by the effect of claying). The ſugar carried away and mixed with the ſcum is recovered, as in the common refineries, by diluting the

ſkimmings with hot water; the ſugar diſſolves in the water, and is ſeparated from the indiſſoluble particles by means of a cloth, which ſerves as a filter: the indiſſoluble particles remain on the ſurface, thoſe which are ſoluble paſs through it; the former is of no uſe but to burn; the latter, as well as the cloudy and clear ſyrups, cryſtalize by the ſame proceſs, and in the ſame utenſils which are uſed for the cane-juice. This cryſtalization being purſued till the maſs is totally exhauſted, the ſugar obtained therefrom is purified in the ſame manner as raw ſugar; the operation is preciſely the ſame, but the droppings which come from it do not cryſtalize ſpontaneouſly; it is effected by evaporation on the fire, which muſt not take place with reſpect to the droppings of raw ſugar, which cannot be expoſed to fire without being entirely decompoſed. When this cryſtalization is purified, purged, or clayed, it makes very white powdered ſugar; which may be ſold as it is, or of which new ſugar may be made by mixing it with clayed ſugar, as it then appears infinitely finer than the clayed ſugar itſelf.

The

The cases to purge raw sugar. They are the exact model of those draining troughs described in the process of the cane-juice, except that they are five feet square, and twenty inches deep; they are placed on trestles, in such a manner that five trestles serve for two cases. The trestles placed at the extremities are flat, that placed in the middle is ariss-shaped; their length must admit of the recipient being placed under the case.

Preparation of the clay. Resembles that observed in the present refineries for claying loaf-sugar; but the clay used to purify or purge raw sugar is thicker than that used to clay loaves, it is carried to the consistence of a thick pap. In witness whereof, &c.

XXXVI.

XXXVI. *Specification of the Patent granted to Mr.* GEORGE DUNNAGE, *of Gloucester-Terrace, Hoxton, in the County of Middlesex; for his Invention of Water-proof Hats, in Imitation of Beaver.*

Dated Nov. 11, 1794.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said George Dunnage, in compliance with the said proviso, do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, is particularly described and ascertained as follows; that is to say, let a shag be woven, of such count in the reed, and cut over such sized wire, as will give the hats to be manufactured from it that degree of richness, or appearance of fur, which may be thought necessary. The materials which this shag may be composed of are various, and should be accommodated to different kinds of hats, according to the degree

of

of beauty and durability to be given them, and the price they are deſigned to be ſold at; that is to ſay, ſilk, mohair, or any other hair that is capable of being ſpun into an end fine enough for the purpoſe, cotton, inkle, wool, or a mixture of any, or all, the above materials, as may ſuit the different purpoſes of the manufacturer. I have made them of ſeveral of the above-mentioned materials, but I think thoſe will anſwer the purpoſe beſt, both with reſpect to beauty and durability, which are made with two poles, either of Bergam, Piedmont, or Organzine, ſilk, riſing alternately, in a reed of about nine hundred count to eighteen inches wide, with three ſhoots over each wire. This method of weaving diſtributes the ſilk, (as it may be put ſingle in the harneſs,) and prevents any ribby appearance which it might have if the ſilk were paſſed double, and the whole of the pole cut over each wire. This may be made either on a two or four thread ground of hard ſilk, ſhot with fine cotton; which I think preferable, for ſhoot, to ſilk, inkle, or any other material, as it forms both a cloſe and fine texture. An inferior kind of hats may be made

from

from any of the before mentioned materials, and with cheaper ſilk. This ſhag ſhould be ſtretched on a frame, ſuch as dyers uſe to rack cloth; then, (having previouſly ſet the pile upright with a comb, to prevent its being injured or ſtuck together,) go over the ground with thin ſize, laid on with a ſoft bruſh. For black, or dark colours, common ſize will do: with white, or any light colour, uſe iſinglaſs, or a ſize made from white kid leather. Theſe, or gum, or any other mucilaginous matter, which, without altering the colour, will prevent oil from getting through the ground ſo as to injure the pile, will anſwer the purpoſe. Take care not to apply more of any material, as a preparation, than may be fully ſaturated with oil or varniſh, ſo that water will not diſcharge it from the ground. The ſize, or other glutinous matter, being dry, the pile muſt be teaſeled, or carded with a fine card, till the ſilk is completely taken out of the twiſt or throwing; when it will loſe its coarſe ſhaggy look, and aſſume the appearance of a very fine fur. It muſt now be once more ſet upright with a comb, and you may proceed to lay on your water-proof ma-

terial;

terial; this too may be varied according to circumſtances. For black, or any dark colour, linſeed oil, well boiled with the uſual driers, and thickened with a ſmall quantity of any good drying colour, will do: for white, or very fine colours, poppy or nut oil, or copal or other varniſhes, may be uſed. In this particular the manufacturer muſt judge what will beſt anſwer his purpoſe, taking care never to uſe any thing that will dry hard, or be ſubject to crack. I have found good drying linſeed oil preferable to any thing I have yet uſed, and, with the precaution of laying on very little the firſt time, it will not injure the fineſt colours. When the firſt coat of oil is dry, go over it a ſecond and a third time, if neceſſary, till you are convinced the pores of the ground are fully cloſed up, and the ſtuff rendered impervious to water. It ſhould now ſtand ſeveral days, till the ſmell is ſufficiently gone off; and, before it is taken from the frame, ſhould be gone over with ſome ox-gall, or lime-water, to take off the greaſineſs, which would otherwiſe prevent the ſtiffening from adhering to the oil. The material, being now ready to be formed into

hats, ſhould be cut into proper ſhapes for that purpoſe. The crown ſhould be made up over a block, with needle and ſilk, the oiled ſide outwards. The ſeams ſhould then be rubbed with a piece of hard wood, bone, or ivory, to make them lie flat, and the edges of the ſtuff pared off very near the ſtitches, that no joint may appear on the right ſide. The ſeams ſhould then be carefully gone over with the prepared oil, till every crevice or hole made by the needle is completely filled up, and the crown rendered perfectly water-proof. The crown may then be turned and ſtiffened, by ſticking linen, leather, paper, or any other material that may be found to anſwer the purpoſe, to the inner or painted ſide, till it acquires about the ſame degree of ſtiffneſs, or reſiſtance to the touch, as a good beaver. The mucilaginous matter I have made uſe of to attach the ſtiffening to the crown, and the upper and under parts of the brim to each other, is compoſed of one pound of gum-arabic or ſenega, one pound of ſtarch, and half a pound of glue, boiled up with as much water as will reduce the whole to the conſiſtence of a thick paſte. A greater or

leſs proportion of any of theſe ingredients may be uſed, and other glutinous and adheſive ſubſtances may anſwer the ſame purpoſes; or drying-oils may be made uſe of, inſtead of this or other mucilage; or any of the reſinous gums diſſolved in oil or ſpirits; only it ſhould be obſerved, in this caſe, the hats will require more time in the preparation, as the oily matter, unleſs expoſed to the air, will not readily dry; but I have found, by experience, that the above mentioned compoſition does not dry hard or brittle, but retains that pleaſant flexibility which is agreeable to the touch, while it communicates to the other materials a ſufficient degree of elaſticity. Before the brim is perfectly dry, care ſhould be taken to form a neck or riſing round the hole where it is to be attached to the crown, by notching it round with a pair of ſciſſors, and then forcing it over a block ſomething larger than you have made the hole, ſo that the uncut ſtuff may turn up, under the lower edge of the crown, about a quarter of an inch. Before you join the crown and brim together, go over the outſide of the neck of the brim, and the inſide of the crown, as high as the neck will

 come,

come, (which ſhould be about half an inch,) with the prepared oil; and, when they are nearly dry, ſo as to adhere to the finger on touching them, put the crown over the neck of the brim, and let them be ſewed ſtrongly together, taking care to ſew down as little of the pile as poſſible, and uſing the ſame precaution of oiling, where the needle has been through, as was obſerved in making up the crown. The hat is now ready for dreſſing; which operation may be performed over a block, with a hot iron, bruſh, &c. in the ſame manner as thoſe commonly called felts. When putting in the lining, be very careful to let the needle only take hold of the under ſurface of the brim; for, ſhould it perforate the upper one, the water will find its way through, and the hat be of no value. In making ladies' hats of bright and fading colours, whoſe principal recommendation will be their looking more beautiful than any of thoſe uſually called beavers, all the precautions I have mentioned, to render them perfectly water-proof, may not be thought neceſſary; as their fading colours muſt naturally preclude the idea of their being much expoſed to the weather; one coat of oil, or varniſh, for inſtance,

ſtance, may in this caſe be thought ſufficient. But, when making hats of black, or any durable colour, (particularly thoſe deſigned for gentlemen's riding-hats,) every precaution I have mentioned ſhould be carefully attended to; when they will not only be ſuperior in beauty to the very beſt beavers, and retain that beauty more than double the time, but poſſeſs the additional advantage of being perfectly water-proof, and much cooler in ſummer; as the ſame water-proof quality will forbid their abſorbing the rays of light, and conſequently prevent their contracting that diſagreeable heat which has been ſo much complained of in felts. In witneſs whereof, &c.

XXXVII.

XXXVII. *Specification of the Patent granted to* David Hartley, *of Golden-square, in the City of Westminster, Esq. for his Invention of a certain Method of tempering all Instruments, and Manufactures, of Steel.*

Dated June 9, 1789.

To all to whom these presents shall come, &c. Now know ye, that, in compliance with the said proviso, I the said David Hartley do hereby declare, that the said invention consists, and is made and performed, in the manner following; *viz.* a new and scientific principle of tempering all edged instruments, and other manufactures, of steel, independent of the mode hitherto accustomed of tempering them by colour, *viz.* by the application and use of any pyrometer, or thermometer, or any other precise or regulated mode of measuring heat, in the hardening and tempering of steel, according to the respective degrees of heat which the respective sorts of steel, or the respective

tive ſorts of edged or other inſtruments of ſteel, may require. The principle which conſtitutes the invention is, the application of the above mentioned mode of meaſuring heat, as the certain and infallible teſt, and means of communicating the reſpective degrees of heat which may be required, uniformly, and without the leaſt variation, through the whole ſubſtance, and every part, of any edged or other inſtrument of ſteel, of what ſhape, or ſize, or deſcription ſoever. The tempering heats are various, according to the various ſorts of ſteel, and the different inſtruments to be tempered: in general they lie between the points of four hundred degrees and ſix hundred degrees, upon Fahrenheit's ſcale of heat. The principle of tempering by thermometrical teſt being eſtabliſhed, the preciſe points of heat are to be adapted to the reſpective ſorts of ſteel, and the reſpective inſtruments to be tempered. It is not poſſible to enumerate all the various ways which may be deviſed for indicating preciſe points of heat by thermometrical teſt: the moſt accurate and comprehenſive deſcription that I can give of the general principle, and manner of applying this

this teſt to the tempering of ſteel, is by putting the thermometrical teſt, whatever it may be, cloſe and contiguous in the ſame place or veſſel, or immerſed in, and ſurrounded by, the ſame medium, of what nature or kind ſoever that medium may be, or of whatever ſubſtance or materials it may conſiſt, for receiving and communicating heat, together with the inſtruments to be tempered; in ſuch manner that, whatever degree of heat ſhall be applied ſo as to effect the inſtruments of ſteel, the ſame degree of heat ſhall be indicated by the thermometrical teſt, and thereby afford certain and preciſe means of adminiſtering and regulating ſuch proper degrees of heat, in tempering of ſteel, as the caſe may require. This is a particular deſcription of the nature of my ſaid invention, and of the manner in which I do uſe and perform the ſame. In witneſs whereof, &c.

XXXVIII.

XXXVIII. *Specification of the Patent granted to* ALEXANDER FORDYCE, *of Harley-Street, Cavendiſh-ſquare, in the Pariſh of St. Mary le Bone, Eſq. for his new-invented Proceſſes by which the Alkali, contained in Sea-Salt, Salt-water, Rock-ſalt, Salt-ſprings, Salt-cake, Glauber's Salt, and vitriolated Tartar, is ſeparated from the marine and vitriolic Acids.*

Dated Auguſt 1, 1781.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, I the ſaid Alexander Fordyce do hereby declare, that the nature of my ſaid invention, and the manner in which it is to be performed, is as follows; *viz.* the nature of my invention, for which I have a patent, of date the firſt of Auguſt laſt, is to obtain from ſea-ſalt, ſalt-water, rock-ſalt, ſalt-ſprings, Glauber's ſalt, or ſalt-cake, a mineral or foſſil alkali; and, from

vitriolated tartar, a vegetable alkali. The manner of performing these operations is, by converting salt-water, salt-springs, sea-salt, and rock-salt, or compositions of these where the saline quality is prevalent, into Glauber's salt, or salt-cake, by the application of vitriolic acid, or any substance containing it. Mix the Glauber's salt, salt-cake, or common salt; strong brine, or what can be converted, in whole or in part, into salt, by crystalization, evaporation, or calcination, with double the quantity of lime, or any other proportion; put them together in a vault, cellar, or any other place covered from the rain; let them stand till part or the whole of the sea-salt, or Glauber's salt, or salt-cake, is decomposed; dissolve out the alkali and crystalize it, or evaporate it to dryness; or, instead or lime, you may use chalk, or any other calcareous earth; or iron, or any thing containing iron. Or take sixty pounds of Glauber's salt, or salt-cake, or vitriolated tartar, ten pounds of iron, and ten pounds of charcoal, or they may be used in various other proportions; afterwards pound them, or throw them in a lump into forty

gallons

gallons of water, or into a larger or ſmaller quantity of it; let them digeſt for twenty-four hours, or a ſhorter or longer time; ſeparate the clear ſolution, evaporate it, and cryſtalize the alkali; or you may uſe the ſolution, and evaporate it to dryneſs; or, inſtead of the charcoal, you may uſe any animal or vegetable inflammable ſubſtance, or coal, or any inflammable ſubſtance which is ſufficiently ſtrong to bear the heat, or any other ſubſtance containing phlogiſton; or, inſtead of the iron, you may uſe any calx of iron, or any ore of iron, or any thing containing iron, or any other metal capable of deſtroying ſulphur. In witneſs whereof, &c.

XXXIX. *Deſcription of a Furnace for Steam-Engines, &c. which effectually conſumes the Smoke ariſing from it. In a Letter to the Editors, from Mr.* William Thomson, *of Bow-Lane.*

WITH A PLATE.

As ſteam-engines are much made uſe of in this kingdom, and, at the ſame time, are often found very diſagreeable on account of their ſmoke; I herewith ſend you a deſcription, and drawing, of a furnace which will effectually conſume the ſmoke ariſing from it, without requiring more coals than uſual, as has been the caſe with former contrivances for that purpoſe. It may be adapted to any boiler or copper already ſet up, and at a very ſmall expence.

Fig. 1, (Plate XVII.) is a ſection of an oblong boiler, and fire-place.

a a a a. The brick work in which boilers are uſually ſet.

A A. The boiler. Two iron flues run through this boiler, and alſo go round it.

B B. The fire-place; which muſt be about one third longer than they are generally made.

C. An arch, which runs acroſs the fire-place, two inches lower than the bottom of the flue under the boiler, and about the middle of the fire-place.

D D D D. Flues through which the hot air aſcends, and ſpends its heat on the boiler.

E. The door of the fire-place; which muſt have a ſmall ſhutter in it. Through this ſhutter the coals muſt be gently ſtirred up, by the ſlice or poker, taking care not to injure the arch, nor to raiſe too great a quantity of coals at once.

F is a ſmall ſpace left behind the fire, for a current of air to come through, as in the patent lamps.

G. A brick placed with its whole length acroſs the fire-place, to hinder the coals from falling down the ſpace F, and choking it.

Fig. 2, is a front-view of the ſame boiler, and fire-place; in which the ſame letters repreſent the ſame parts.

H H are two ſlides, the one ſhifting backwards the other forwards, to make the ſpace F, for the current of air, larger or ſmaller, as, by practice, may be found beſt.

Manner in which this Furnace operates.

The arch C hinders the ſmoke from going up the chimney, and obliges it to paſs through the fire behind it; which has a very ſtrong draught, and burns the ſmoke as it paſſes through it. The air which comes up through the ſpace F gives freſh vigour to the flame, which conſumes any ſmoke that may be left.

It muſt be obſerved that too much air will have a very bad effect, as it will cool the flame; therefore the ſlides H H muſt be regulated in ſuch manner as the operator may find moſt advantageous.

The ſhutter in the door E muſt alſo be of a proper ſize; as its being too large or too ſmall will be prejudicial.

I am, &c.

W. Thomson.

XL.

Fig. 1.

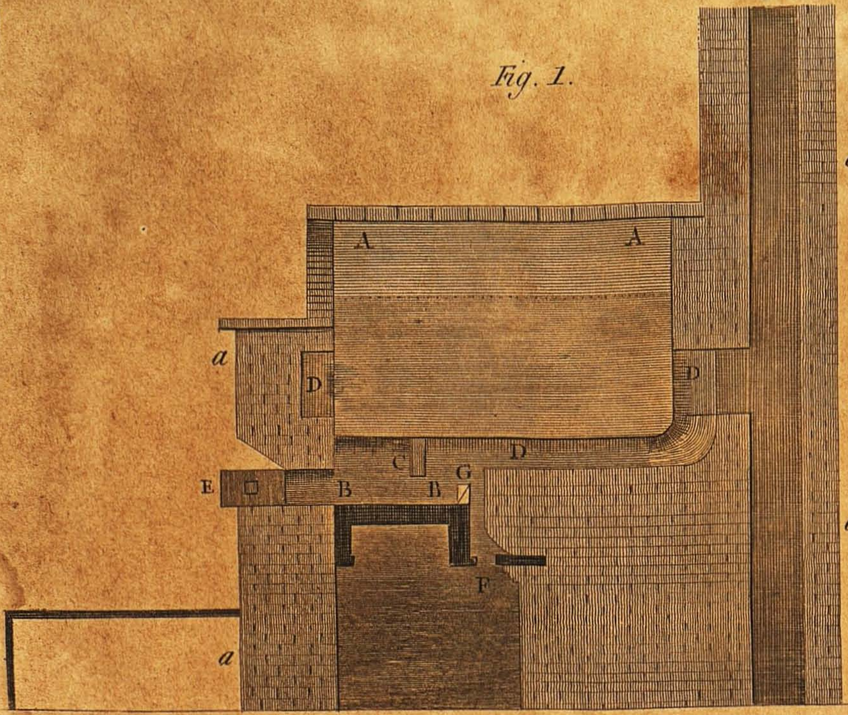
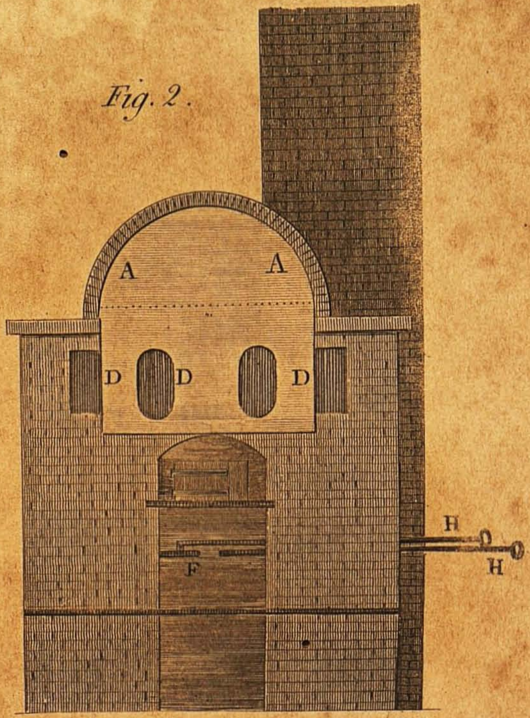


Fig. 2.



XL. *Defcription of an improved Mill for grinding Corn, as built in Virginia; by Mr.* Thomas Ellicott, *Mill-Wright.*

WITH A PLATE.

By the new improvements made in corn-mills, the manufacture of grain into flour is carried on, by force of water, with very little hand-labour, and much lefs wafte than before, either in fmall or large quantities; and I believe that, taking a large quantity of wheat together, we can make two or three pounds more out of a bufhel by the new than by the old way, (although it is equally well ground,) becaufe it is fo much more completely bolted, and with lefs wafte. In the old way, the wheat is weighed, then carried up one or two pair of ftairs, and thrown into garners; and, as the bags often have holes in them, it is fpilt and trampled under foot, feveral pounds being

ing frequently loſt in receiving a ſmall quantity. When it is taken from the garners and carried to the rolling-ſcreens, ſome of it is again waſted; and as it is ground it is ſhoveled into tubs, by which a duſt is raiſed, and ſome ſpilt and trampled on. It is then hoiſted and ſpread, and toſſed about with ſhovels, over a large floor, raked, and turned to cool, then ſhoveled up again, and put into the bolting-hoppers; all which occaſions great labour, and conſiderable waſte, from what is ſpilt and trampled over the mill. Beſides theſe diſadvantages, there are others attending the bolting-hoppers; they are often ſuffered to run empty, then filled too hard, ſo that they choke; this occaſions the flour to be very unevenly bolted, being ſometimes too poor, and at other times too rich, which occaſions a conſiderable loſs. When the flour is bolted, it is much finer at the head than at the tail of the cloths: the fine goes through firſt, and muſt be mixed, by hand, with ſhovels or rakes; this labour is often neglected, or only half done; by which means part of the flour will be condemned as being too poor, and

4 the

the reſt will be above the ſtandard quality. The hoiſting of the tail flour, mixing it with bran, by hand, and bolting it over, are attended with ſo much labour that they are ſeldom done to perfection.

In the new way, all theſe inconveniences and diſadvantages are completely provided againſt. A repreſentation of the various parts of the machinery is given in Plate XVIII; ſhewing the manner in which they are made uſe of in the whole proceſs of the manufacture; taking the grain from the ſhip or waggon, and paſſing it through the ſeveral operations, until it is completely manufactured into ſuperfine flour. In that manner they are now applied, and are in actual practice, in a mill planned by me, and built on Occoquam river in Virginia, with three water-wheels, and ſix pair of ſtones.

If the wheat comes by water to the mill in the ſhip Z, it is meaſured and poured into the hopper A; thence it is conveyed, by the conveyer * B, into

* The conveyer is an endleſs ſcrew, of two continued ſpires, put in motion in a trough. The grain is let in at one end, and

into the elevator * C; this elevates it, and drops it into the conveyer D E, which conveys it along, under the joifts of the fecond floor, and drops it into the hopper-garner at E. From this it is conveyed into the main wheat-elevator at F, which carries it up into the peak of the roof, and delivers it into the rolling-fcreen at G, which (in this

and the fcrew drives it to the other, or collects it at the centre: or the grain may be let in at the middle, and conveyed towards each end. The fhaft of the conveyer is round, and the fpires may be made either of ftrong fheet-iron or of wood. If they are made of iron, and punched full of fmall holes, like a grater, and the trough lined with fheet-iron, alfo punched full of fmall holes, an excellent rubber will be formed; which will clean the wheat from the duft and down which adhere to it, and fuperfede the neceffity of any other rubbing-machine.

* The elevator is an endlefs ftrap, revolving over two pulleys, one of which is fet where the meal, or grain, &c. is to be hoifted from, and the other where it is to be hoifted to; to this ftrap is faftened a number of fmall buckets, which fill themfelves as they pafs under the lower pulley, and empty themfelves as they pafs over the upper one. To prevent wafte of what may be fpilt out of thefe buckets, the ftrap, buckets, and pulleys, are all inclofed, and work in tight cafes, fo that what is fpilt will defcend to the place whence it was hoifted. The buckets may be made either of wood or of fheet-iron.

plan)

plan) is above the collar-beams; out of this it falls into the hopper H, thence into the ſhort elevator at I, which conveys it up into the fan J; whence it runs down ſlanting into the middle of the long conveyer at K, which extends towards both ends of the mill, and conveys the grain, as cleaned, into any of the garners L L L L L, which are over the ſtones M M M M M M; this is done by ſhifting a board under the fan, ſo as to guide the grain to either ſide of the cog-wheel K; and, although each of theſe garners ſhould contain two thouſand buſhels of wheat over each pair of ſtones, (twelve thouſand buſhels in ſix garners,) yet nearly all this may be ground without handling it, and the ſtones be fed more evenly and regularly than is poſſible in the old way. As the wheat is ground by the ſeveral pair of ſtones, the meal falls into the meal conveyer * at N N N N N, and

* The meal-conveyer is compoſed of an eight-ſided ſhaft, (in a trough,) ſet on all ſides with ſmall inclining boards, called flights, which ſerve to convey the meal from one end of the trough to the other. Theſe flights are ſet in a ſpiral line;

and is conveyed into the common meal-elevator at O, which raises it to P; thence it runs down to the hopper-boy * at Q, which spreads and cools

line; but, being set across the said line, they operate like ploughs. Besides these conveying flights, half as many of another kind, called lifting-flights, are sometimes found necessary. These are placed with their broadsides foremost upon the shaft, so as to raise the meal on one side, and let it fall on the other side, of the shaft, to cool; these lifting flights are only used when the meal is hot, and the conveyer short. This conveyer is often applied to cool the meal without the hopper-boy, and to supply the bolting-hoppers, by extending the conveyer to a great length, and conveying the meal immediately into the hoppers; this it does very well, and some prefer it, but a hopper-boy is better, where there is room for one.

* The hopper-boy consists of a perpendicular shaft, which is put into slow motion, (not making above four revolutions in a minute,) carrying round with it a horizontal piece, (called the arm or arms,) which is set, on the under side, full of small inclining boards, called flights; they are set so as to gather the meal towards the centre, or spread it from the centre to that part of the arm which passes over the bolting-hopper; at which part one board is set broad-side foremost, called a sweeper, which drives the meal before it, and drops it into the hoppers, as the arms pass over them. The meal is generally let fall from the

cools it over a circle of ten or fifteen feet diameter; and (if thought beſt) will raiſe over it, and form

a heap

the elevator at the extremity of the arm, where alſo there is a ſweeper, which drives the meal before it, trailing it in a circle the whole way round, ſo as to diſcharge nearly the whole of its load by the time it returns to be loaded again; the flights then gather it towards the centre from every part of the circle, which would not be the caſe if the ſweepers did not lay it round, for then the meal would be gathered from only one ſide of the circle. Theſe ſweepers are ſcrewed on the back of the arm, ſo that they may be raiſed or lowered, in order to make them diſcharge ſooner or later, as may be neceſſary. The extreme flights, at the end of the arms, are put on by a ſcrew paſſing through their centre, ſo that they may be turned to drive the meal outwards; the uſe of which is to ſpread the warm meal, as it falls from the elevator, in a ring round the hopper-boy, while it, at the ſame time, gathers the cool meal into the bolting-hoppers; ſo that the cool meal may be bolted, and the warm meal ſpread to cool, by the ſame machine, and at the ſame time, if the miller chooſes it to be ſo. The lower end of the upright ſhaft is made round, and paſſes looſely through a round hole in the flight-arm, which gives the arm liberty to riſe or fall freely, to ſuit any quantity of meal under it; its foremoſt edge being ſloped up, in order to make it riſe over the meal. The arm is kept ſteady by a ſtay-iron, which

alſo

a heap two or three feet high, perhaps thirty barrels of flour, or more, at a time, which may be bolted down at pleasure. While it is bolting, the hopper-boy gathers it into the bolting-hoppers at R, and supplies them more regularly than is ever done by hand. As it is bolted, the conveyer S, at the bottom of the superfine chest, conveys the superfine flour, by means of a hole in the floor at T, into the packing-chest, which mixes it completely. Out of the packing-chest it is filled into the barrel at U, weighed in the scale V, packed at W, by water, headed at X, and rolled to the

also fits loosely round the shaft, and it is kept at a proper height upon the shaft by a weight hung to one end of a cord, which, after passing over a pulley, is fastened to the stay-iron; it is carried round by an arm (called the leading arm) at the top of the shaft, to which arm the flight-arm is connected by means of ropes. Hopper-boys should be moved by a strap, in some part of their movement, that they may easily stop if any thing in them should catch; but some ingenious mill-wrights prefer cogs.

All these improvements, described in the notes, are patent inventions of Oliver Evans, of Philadelphia.

door

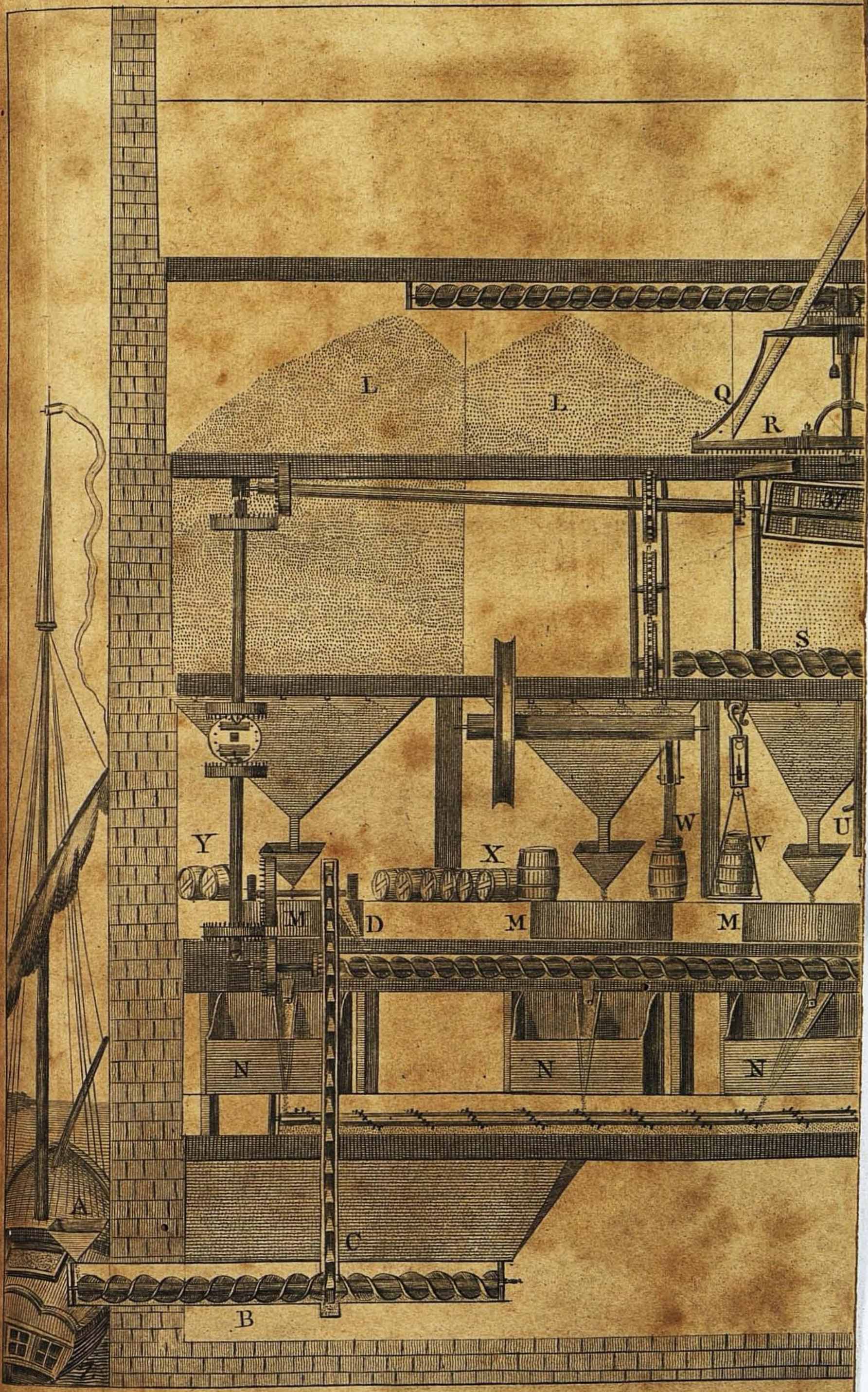
door Y, when lowered down by a rope and windlaſs into the ſhip again at Z.

If the wheat comes to the mill by land, in the waggon 7, it is emptied from the bags into a ſpout which is fixed in the wall, and runs into the ſcale 8, which is large enough to hold a waggon-load; as it is weighed, it is let run, by drawing a door at the bottom of the ſcale, into the garner E, out of which it is conveyed into the elevator at F, and ſo through the proceſs before deſcribed.

As much of the tail of the ſuperfine reel 37 as we think will not paſs inſpection, we ſuffer to paſs on into the ſhort elevator 38, by ſhutting the doors at the bottom of the conveyer next the elevator, and opening one farther on towards the other end. The rubblings which fall at the tail of the ſaid reel are alſo hoiſted into the bolting-hoppers of the ſifting reel 39, which is covered with a fine cloth, to take out all the fine flour duſt which ſticks to the bran in warm damp weather; and all that paſſes through it is conveyed by the conveyer 40 into the elevator 41, which elevates

 it

it ſo high that it will run freely to the hopper-boy, and it is bolted over again with the ground meal. The rubblings, which fall at the tail of the ſifting reel 39, fall into the hopper of the middlings reel 42, and the bran falls at the tail into the lower ſtory. Thus you have it in your power, either by day or night, without any hand-labour, except to ſhift the ſliders, or ſome ſuch trifle, to make your flour to ſuit the ſtandard quality; and the fineſt poſſible is made out of the grain, and completely finiſhed at one operation.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XLI. *Continuation of the Count of Rumford's Method of measuring the Intensities of the Light emitted by luminous Bodies.*

(FROM P. 270.)

As the lower ends of the cylinders, which pass through the holes made to receive them in the bottom of the box, are about $\frac{1}{20}$ of an inch less in diameter than their upper parts, which cast the shadows, and as they not only go quite through the bottom of the box, (which is an inch thick,) but project near an inch below its inferior surface, and lastly, as these cylinders are not firmly fixed in these holes, it is easy, by taking hold of the ends of them, which project below the bottom of the box, to turn about the cylinders upon their axes, even without opening the box. I said above, that the height of the vertical wing attached to each of the cylinders was equal to the

the height of the cylinder itſelf: this muſt be underſtood to mean, not the total length of the cylinder, comprehending that part of it which paſſes into, and through, the bottom of the box, but merely its height above the bottom of the box, or part projecting, namely $2\frac{2}{10}$ inches.

As it is abſolutely neceſſary that the cylinders ſhould conſtantly remain preciſely perpendicular to the bottom of the box, or parallel to each other, it will be beſt to conſtruct them of braſs; and, inſtead of fixing them immediately to the bottom of the box, (which, being of wood, may warp,) to fix them to a ſtrong thick piece of well-hammered plate braſs; which plate of braſs may be afterwards faſtened to the bottom of the box, by means of one ſtrong ſcrew. In this manner two of my beſt inſtruments are conſtructed; and in order to ſecure the cylinders ſtill more firmly in their vertical poſitions, they are furniſhed with broad flat rings, or projections, where they reſt upon the braſs plate; which rings are $\frac{1}{10}$ of an inch thick, and equal in diameter to the projection of the wing of the cylinder, to the bottom of which they afford a firm ſupport. Theſe cylin-

ders

ders are likewiſe forcibly puſhed, or rather pulled, againſt the braſs plate upon which they reſt, by means of compreſſed ſpiral ſprings, placed between the under ſide of that plate and the lower ends of the cylinders.

Of whatever material the cylinders be conſtructed, and whatever be their forms or dimenſions, it is abſolutely neceſſary that they, as well as every other part of the *photometer*, except the field, ſhould be well painted of a deep black dead colour. That will prevent the inconveniences which would otherwiſe ariſe from reflected light, and from the preſence of too great a number of viſible objects.

In order to move the lights to and from the *photometer* with greater eaſe and preciſion, I have provided two long and narrow, but very ſtrong and ſteady, tables; in the middle of each of which there is a ſtraight groove, in which a ſliding carriage, upon which the light is placed, is drawn along by means of a cord which is faſtened to it before and behind, and which, paſſing over pulleys at each end of the table, goes round a cylinder; which cylinder is furniſhed with a winch, and is

 ſo

ſo placed, near the end of the table adjoining the *photometer*, that the obſerver can turn it about, without taking his eye from the field of the inſtrument.

Many advantages are derived from this arrangement; firſt, the obſerver can move the lights as he finds neceſſary, without the help of an aſſiſtant, and even without removing his eye from the ſhadows; ſecondly, each light is always preciſely in the line of direction in which it ought to be, in order that the ſhadows may be in contact in the middle of the vertical plane of the *photometer*; and, thirdly, the ſliding motion of the lights being perfectly ſoft and gentle, that motion produces little or no effect upon the lights themſelves, either to increaſe or diminiſh their brilliancy.

Theſe tables, which are 10 inches wide and 35 inches high, and the one of them 12 feet and the other 20 feet long, are placed at an angle of 60° from each other, and in ſuch a ſituation, with reſpect to the *photometer*, that lines drawn through their middles, in the direction of their lengths, meet in a point exactly

under

under the middle of the vertical plane or field of the *photometer*, and from that point the diſtances of the lights are meaſured; the ſides of the tables being divided into Engliſh inches, and a vernier, ſhewing tenths of inches, being fixed to each of the ſliding carriages upon which the lights are placed.

Theſe carriages are ſo contrived that they can be raiſed or lowered at pleaſure, which is abſolutely neceſſary, in order that the lights may be always of a proper height, namely, that they may be in a horizontal line with the tops of the cylinders of the *photometer*.

The method of aſcertaining when the lights are at the proper height has already been deſcribed.

In order that the two long and narrow tables, or platforms, juſt deſcribed, upon which the lights move, may remain immovable in their proper poſitions, they are both firmly fixed to the ſtand which ſupports the *photometer*; and, in order that the motion of the carriages which carry the lights may be as ſoft and gentle as poſſible, they are made to ſlide upon parallel braſs wires, 9 inches aſunder, about $\frac{1}{10}$ of an inch in diameter,

and

and well poliſhed, which are ſtretched out upon the tables from one end to the other.

The pane of glaſs covered with white paper, which, being fixed in a groove in the back of the box, conſtitutes the vertical plane upon which the ſhadows are projected, is 5½ inches long, and 3¼ inches wide, as has already been obſerved; which is much larger than the dimenſions aſſigned above for the field, namely, 1$\frac{7}{10}$ inch wide, and 2 inches high. I had two objects in view in this arrangement; firſt, to render it eaſier to fix this plane in its proper poſition; and ſecondly, to be able to augment occaſionally the dimenſions of the field, by removing entirely the black paſteboard ſcreen from before this plane, or making uſe of another with a larger aperture; which is ſometimes advantageous *.

Having

* Since writing the above, I have made a little alteration in the form of the box which contains my *photometer*. The front of it, inſtead of being open, is now cloſed, and the light is admitted through two horizontal tubes, which are placed ſo as to form an angle of 60°; their axes meeting at the centre of the field of the inſtrument. The field of the *photome-*

ter

Having now, as I imagine, ſufficiently deſcribed all the eſſential parts of theſe inſtruments, it remains for me to give ſome account of the precautions which, from experience, I have found it neceſſary to take in making uſe of them.

And firſt, with reſpect to the diſtance at which lights, whoſe intenſities are to be compared, ſhould be placed from the field of the *photometer*, I have found that, when the weakeſt of the lights in queſtion is about as ſtrong as a common wax-candle, that light may moſt advantageouſly be placed from 30 to 36 inches from the centre of the field; and when it is weaker or ſtronger, proportionally nearer or farther off. When the lights are too near, the ſhadows will not be well defined; and when they are too far off, they will be too weak.

It will greatly facilitate the calculations neceſſary in drawing concluſions from experiments of

ter is viewed through an opening, made for that purpoſe, in the middle of the front of the box, between the two tubes above mentioned. The annexed figures (ſee Plates XXI, XXII, and XXIII.) will ſerve to give a clearer idea of the inſtrument, as it now is, in its moſt improved ſtate.

this

this kind, if ſome ſteady light, of a proper degree of ſtrength for that purpoſe, be aſſumed as a ſtandard by which all others may be compared. I have choſen for that purpoſe an Argand's lamp, made in London, and very well finiſhed; and though the quantity of light, emitted by this or any other kind of lamp, is very various, depending in a great meaſure upon the length to which the wick is drawn out, yet I have found, by repeated trials, that this lamp, once properly adjuſted, continues to emit light more equally for a conſiderable time than any other lamp, and much more ſo than any candle whatever.

At the beginning of each experiment I adjuſt this ſtandard-light in the following manner. Having placed the lamp upon its carriage, at the diſtance of 100 inches from the centre of the field of the *photometer*, meaſuring from the centre of the circular flame of the lamp, a cylindric wax-candle, of known weight and dimenſions, and which is kept merely for that purpoſe, being lighted and trimmed, and made to burn with the greateſt poſſible degree of brilliancy, is placed over againſt it, at a certain given diſtance, (33 inches,) and then

then the wick of the lamp is drawn out, or ſhortened, as is found neceſſary, till the ſhadows correſponding to the lamp and to the candle are preciſely of the ſame denſity; this done, the proof-candle is extinguiſhed, and laid by for farther uſe, and the projected experiment is immediately commenced.

Here the proof-candle is, properly ſpeaking, the ſtandard; but the lamp is to be preferred to it for the experiments, on account of the ſuperior conſtancy or equality of its light.

The only danger of error in this matter ariſes from the difficulty of procuring proof-candles which ſhall always give preciſely the ſame quantity of light, or of making the ſame candle burn with exactly the ſame brilliancy at different times. I flattered myſelf at one time that even this cauſe of error and uncertainty, however inſurmountable the difficulty appears, might be in a great meaſure removed. I conceived that if the light from the ſtandard-lamp, and that of the proof-candle, brought to be of the ſame intenſity at the ſurface of the vertical plane, were really ſtronger at one time than at another, the equal

ſhadows of the cylinders would be proportionally deeper; and that by comparing, at different times, the denſity of thoſe ſhadows with a painted ſcale of ſhades, regularly graduated, any difference in the intenſity of the ſtandard-light might be diſcovered and compenſated; but upon making the experiment I found, what indeed a little patient reflection would have enabled me to foreſee, that the apparent denſity of the two equal ſhadows correſponding to the lights, compared with a painted ſcale of ſhades, *expoſed in the ſame light*, is ever the ſame, however the intenſity of the rays, at the ſurface upon which thoſe ſhadows are projected, may vary.

There is, however, another method by which I think it probable that the ſtandard-lamp may be adjuſted with the requiſite degree of preciſion. It appears, from a conſiderable number of experiments, of which I ſhall hereafter give a more particular account, that the quantity of light emitted by a lamp which burns in the ſame manner, with a clear flame, *and without ſmoke*, is in all caſes as the quantity of oil conſumed. If, therefore, the ſtandard lamp be ſo adjuſted as al-

ways

ways to confume a certain given quantity of oil in a given time, there is much reafon to fuppofe that it may then be depended on as a juft ftandard of light.

In order to abridge the calculations neceffary in thefe inquiries, it will always be advantageous to place the ftandard-lamp at the diftance of 100 inches from the *photometer*, and to affume the intenfity of its light at its fource equal to unity; in this cafe, (calling this ftandard light A, the intenfity of the light at its fource $= x = 1$, and the diftance of the lamp from the field of the *photometer* $= m = 100$,) the intenfity of the illumination at the field of the *photometer* $(= \frac{x}{m^2})$ * will be expreffed by the fraction $\frac{1}{100^2} = \frac{1}{10000}$; and the relative intenfity of any other light which is compared with it, according to the directions before given, may be found by the following proportion: calling this light B, putting $y =$ its intenfity at its fource, and $n =$ its diftance from the field of the *photometer*, expreffed in Englifh inches, as it is

* See Page 258.

 y

$\frac{y}{n^2} = \frac{x}{m^2}$ as was ſhewn in the former part of this account; or, inſtead of $\frac{x}{m^2}$, writing its value = $\frac{1}{10000}$, it will be $\frac{y}{n^2} = \frac{1}{10000}$; and conſequently y is to 1 as n^2 is to 10000: or the intenſity of the light B at its ſource, is to the intenſity of the ſtandard-light A at its ſource, as the ſquare of the diſtance of the light B from the middle of the ſidel of the inſtrument, expreſſed in inches, is to 10000; and hence it is $y = \frac{n^2}{10000}$.

Or, if the light of the ſun, or that of the moon, be compared with the light of a given lamp or candle C, the reſult of ſuch compariſon may beſt be expreſſed in words, by ſaying, that the light of the celeſtial luminary in queſtion, *at the ſurface of the earth*, or, which is the ſame thing, at the field of the *photometer*, is equal to the light of the given lamp or candle, *at the diſtance found by the experiment*; or, putting a = the intenſity of the light of this lamp C at its ſource, and p = its diſtance, in inches, from the field, when the ſhadows correſponding to this light, and that correſponding to the celeſtial luminary in queſtion, are

found

found to be of equal denſities, and putting $z=$ the intenſity of the rays of the luminary at the ſurface of the earth, the reſult of the experiment may be expreſſed thus, $z=\frac{a}{p^2}$; or the real value of *a* being determined by a particular experiment, made expreſſly for that purpoſe with the ſtandard-lamp, that value may be written inſtead of it. When the ſtandard-lamp itſelf is made uſe of, inſtead of the lamp C, then the value of *a* will be 1.

I have been the more particular in this account of the inſtruments employed in theſe inquiries, the manner in which the experiments were conducted, and the principles upon which the concluſions drawn from them are founded, not only becauſe, the ſubject being new, the moſt particular information upon all theſe points is abſolutely neceſſary, to enable others to judge with certainty of the matter ſubmitted to their examination, but alſo becauſe I was very deſirous of affording every information and aſſiſtance in my power to thoſe who may be diſpoſed to proſecute theſe very curious and entertaining reſearches.

5 Hoping

Hoping that this apology may be thought ſufficient to excuſe the prolixity of theſe deſcriptions, I ſhall now proceed to give a ſhort account of ſuch experiments as I have hitherto found leiſure to make with this apparatus.

My firſt attempts were to determine how far it might be poſſible to aſcertain, by direct experiments, the certainty of the aſſumed law of the diminution of the intenſity of the light emitted by luminous bodies; namely, that the intenſity of the light is every where as the ſquares of the diſtances from the luminous body inverſely. Theſe experiments appeared to me the more neceſſary, as it is quite evident that this law can only hold good when the light is propagated in perfectly tranſparent or unreſiſting ſpaces; or where, ſuffering no diminution whatever from the medium, its intenſity is weakened merely in conſequence of the divergency of the rays; and as it is more than probable that air, even in its pureſt ſtate, is far from being perfectly tranſparent.

For greater perſpicuity, I ſhall arrange all my experiments and enquiries under general heads; and ſhall begin by prefixing to thoſe which relate

to

to the ſubject now under conſideration the general title of

Experiments upon the Reſiſtance of the Air to Light.

Experiment I.

Two equal wax-candles, well trimmed, and which were found, by a previous experiment, to burn with exactly the ſame degree of brightneſs, were placed *together*, on one ſide, before the *photometer*, and their united light was counterbalanced by the light of an Argand's lamp, well trimmed, and burning very equally, placed on the other ſide over againſt them. The lamp was placed at the diſtance of 100 inches from the field of the *photometer*, and it was found that the two burning candles (which were placed as near together as poſſible, without their flames affecting each other by the currents of air they produced) were juſt able to counterbalance the light of the lamp at the field of the *photometer*, when they were placed at the diſtance of 60,8 inches from that field. One of the candles being now taken away,

and extinguiſhed, the other was brought nearer to the field of the inſtrument, till its light was found to be juſt able, ſingly, to counterbalance the light of the lamp; and this was found to happen when it had arrived at the diſtance of 43,4 inches.

In this experiment, as the candles burnt with equal brightneſs, it is evident that the intenſities of their united and ſingle lights were as 2 to 1, and in that proportion ought, according to the aſſumed theory, the ſquares of the diſtances, 60,8 and 43,4, to be; and, in fact, $\overline{60{,}8}^2 = 3696{,}64$ is to $\overline{43{,}4}^2 = 1883{,}56$ as 2 is to 1 very nearly.

Again, in another experiment (N° 2.), the diſtances were,

With two candles = 54 inches.	Square	= 2916
With one candle = 38,6	- -	= 1489,96

Upon another trial, (Experiment N° 3.)

With two candles = 54,6 inches.	Square	= 2981,16
With one candle = 39,7	- -	= 1576,09

And,

And, in the fourth experiment,

With two candles = 58,4 inches. Square = 3410,56
With one candle = 42,2 - - = 1780,84

And, taking the mean of the results of these four experiments,

	Squares of the Distances With two Candles.		Squares of the Distances With one Candle.
In the Experiment N°. 1,	3696,64	—	1883,56
N°. 2,	2916	—	1489,96
N°. 3,	2981,16	—	1576,09
N°. 4,	3410,56	—	1780,84
	4) 13004,36		4) 6730,45
Means	3251,09	and	1682,61

which again are very nearly as 2 to 1.

With regard to these experiments it may be observed, that were the resistance of the air to light, or the diminution of the light from the imperfect transparency of air, sensible within the limits of the inconsiderable distances at which the

candles were placed from the *photometer*, in that caſe the diſtance of the two equal lights united ought to be, to the diſtance of one of them ſingle, in a ratio leſs than that of the ſquare root of 2 to the ſquare root of 1. For if the intenſity of a light emitted by a luminous body, *in a ſpace void of all reſiſtance*, be diminiſhed in the proportion of the ſquares of the diſtances, it muſt of neceſſity be diminiſhed in a ſtill higher ratio when the light paſſes through a reſiſting medium, or one which is not perfectly tranſparent; and from the difference of thoſe ratios, namely, that of the ſquares of the diſtances, and that other higher ratio found by the experiment, the reſiſtance of the medium might be aſcertained. This I have taken much pains to do with reſpect to air, but have not as yet ſucceeded in theſe endeavours, the tranſparency of air being ſo great, that the diminution which light ſuffers in paſſing through a few inches, or even through ſeveral feet of it, is not ſenſible.

Having found, upon repeated trials, that the light of a lamp, properly trimmed, is incomparably

bly more equal than that of a candle, whoſe wick, continually growing longer, renders its light extremely fluctuating, I ſubſtituted lamps to candles in theſe experiments, and made ſuch other variations in the manner of conducting them as I thought bid fair to lead to a diſcovery of the reſiſtance of the air to light, were it poſſible to render that reſiſtance ſenſible within the confined limits of my machinery.

Having provided two lamps, the one an Argand's lamp, which I made to burn with the greateſt poſſible brilliancy; the other a ſmall common lamp, with a ſingle, round, and very ſmall wick, which, burning with a very clear ſteady flame, and without any viſible ſmoke, emitted only about $\frac{1}{15}$ part as much light as the Argand's lamp; theſe lamps being placed over againſt each other before the field of the *photometer*, their lights were found to be in equilibrium when, the leſs being placed at the diſtance of 20 inches from the centre of that field, the greater was removed to the diſtance of 101 inches. I now concluded, that, if the leſs light were to be re-

moved to the diſtance of 40 inches, it would be neceſſary, in order to reſtore the equilibrium of light, or equality of the ſhadows in the field of the *photometer*, to remove the greater light to the diſtance of 202 inches; that is to ſay, if the diminution of the light ariſing from the imperfect tranſparency of the air ſhould not be perceptible within the limits of that diſtance. But if, on the contrary, it ſhould be found, upon repeated trials, that the equilibrium was reſtored when the greater light had arrived at a diſtance *ſhort* of 202 inches, I might thence conclude, that ſuch effect might ſafely be attributed to the imperfect tranſparency of the air; for notwithſtanding that the light of the ſmaller lamp would of courſe be diminiſhed, as well as that of the greater, yet as there is every reaſon to ſuppoſe that the diminution, whatever it may be, muſt ever be proportioned to the diſtance through which the light paſſes in the medium, as the augmentation of the diſtance through which the light of the ſmaller lamp paſſes is no more than 20 inches, while that of the greater is made to paſs through an additional diſtance,

distance, amounting to more than 100 inches, it is evident that the diminution of the light of the greater lamp, arising from the imperfect transparency of the medium, must be greater than the diminution of the light of the less lamp, arising from the same cause; and consequently, that the effects of such diminution would become apparent in the experiment, were they in reality considerable.

The following table will shew the results of the experiments which were made with a view to determine that fact.

Ex-

Experiments.	Diftunce of the fmaller Light.	Inches.	Diftance of the greater Light.	Inches.	Second diftance of he greater light, *computed* accord ng to the affumed law of the fquares of the diftances. Inches.	Difference between the refult of the experiments and the theory. Inches.
N° 5.	First diftance,	20	Firft dift.	101		
	Second dift.	40	Second dift.	203	202	+ 1
N° 6.	Firft dift.	20	Firft dift.	100,2		
	Second dift.	40	Second dift.	198,3	200,4	— 2,1
N° 7.	Firft dift.	20	Firft dift.	100,8		
	Second dift.	40	Second dift.	202,1	201,6	+ 0,5
N° 8.	Firft dift.	20	Firft d ft.	101,5		
	Second dift.	40	Second dift.	204	203	+ 1
N° 9.	Firft dift.	50	Firft dift.	100		
	Second dift.	100	Second dift.	198	200	— 2
N° 10.	Firft dift.	50	Firft dift.	95,5		
	Second dift.	100	Second dift.	192,2	191	+ 1,2
N° 11.	Firft d ft.	50	Firft dift.	95,1		
	Second dift.	100	Second dift.	191,2	190,2	+ 1
N° 12.	Firft dift.	50	Firft dift.	96		
	Second dift.	100	Second dift.	192,4	192	+ 0,4

In

In the four last experiments, instead of the small lamp above described, a common Argand's lamp was made use of, the wick of which was only drawn out so far as to cause it to emit about $\frac{1}{4}$ part as much light as the other Argand's lamp burning with its greatest brilliancy, which was placed over against it.

In order that, in judging of the equality of the shadows, my mind might be totally unbiassed by my expectations, or by any opinions I might previously have formed with respect to the probable issue of the various experiments, keeping my eye constantly fixed upon the field of the *photometer*, and causing the light whose corresponding shadow was to be brought to be of equal density with the standard to move backwards and forwards, by means of the winch which I had constantly in my hand, as soon as the shadows appeared to me to be perfectly equal, I gave notice to an assistant to observe, and silently to write down, the distance of the lamp or candle; so that I did not even know what that distance was till the experiment was ended, and till it was too late to attempt to correct any supposed errors of my

eyes

eyes by my wiſhes, or by my expectations, had I been weak enough to have had a wiſh in a matter of this kind. I do not know that any predilection I might have had for any favourite theory would have been able to have operated ſo ſtrongly upon my mind, and upon my ſenſes, as to have made black and white appear to me otherwiſe than as they really were; but this I know, that I was very glad to find means to avoid being led into temptation.

But to return to the foregoing experiments; the reſults of them, ſo far from affording means for aſcertaining the reſiſtance of the air to light, do not even indicate any reſiſtance at all; on the contrary, it might almoſt be inferred, from ſome of them, that the intenſity of the light emitted by a luminous body in air is diminiſhed in a ratio *leſs* than that of the ſquares of the diſtances; but as ſuch a concluſion would involve an evident abſurdity, namely, that light moving in air, its abſolute quantity inſtead of being diminiſhed actually goes on to *increaſe*, that concluſion can by no means be admitted.

TO BE CONCLUDED IN OUR NEXT.

XLII. *Account of a Method of granulating Potatoes, or reducing them into the Form of a Grain, like Rice; by* M. GRENET.

WITH A PLATE.

From the JOURNAL of the LYCEUM of ARTS of PARIS.

THE abſolute neceſſity of finding means to ſupply the want of bread we have laboured under has at laſt taught us that the potatoe root, which has been ſo long neglected by us, is highly worthy of our attention; as being one of our moſt valuable reſources, provided we know how to draw from it all the advantages it is capable of.

We therefore take the firſt opportunity of making public a ſimple method (and on that account very valuable) of preſerving that root in the moſt uſeful form, either for daily conſumption in our houſehold œconomy, or for the purpoſes of commerce.

We hope ſoon to be poſſeſſed of every intereſting information that has already appeared on this ſubject, which deſerves the moſt ſerious attention, as it relates to the ſubſiſtence of the people; and we ſhall endeavour to ſhew how important it is, that the government ſhould earneſtly attend to a reſource which is ſo fruitful as to be capable of guarding us from ever feeling again the cruel want we now feel, and of relieving us from being, as we have hitherto been, obliged to pay other nations for an article of the firſt neceſſity.

At preſent, however, we will only conſider how potatoes may be moſt conveniently made uſe of; and how to employ a cheap and ſimple machine, by means of which all the inconveniencies which attend the general uſe of potatoes may be remedied.

Theſe inconveniencies are chiefly the following: firſt, that potatoes are exceſſively heavy, and conſequently not eaſily carried from place to place; ſecondly, that, when ſtowed away, they occupy a great deal of ſpace; thirdly, that they are apt to grow, and are alſo ſubject to bruiſes, and other accidents which ſpoil them. A remedy for

all

all theſe inconveniencies is to be had by making uſe of the ſimple machine, already mentioned, which we now proceed to deſcribe.

Deſcription of the Machine for granulating Potatoes.

AA (Plate XIX.) is a thick plank of wood, about eight feet long, and about eight inches broad, under which are fixed, along its whole length, two ſtrong pieces of wood, three inches ſquare. Into this plank are firmly fixed, by pegs which are driven in underneath the plank, two uprights B and C; between theſe is placed a lever DD, formed of a board, turned edgeways, and let into the top of the upright B, where it turns, upon a pin, in ſuch a manner that it can move freely up and down in a mortiſe made in the upright C. In the middle of this lever, between the uprights, is placed a round wooden piſton, or peſtle, E; the head of which is divided by a mortiſe, ſo as to take in the lever DD, to which it is made faſt, by a pin going through both, in ſuch a manner that it has a free motion

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upon the pin which ſerves to fix it. A ſmall bracket is fixed upon the lever at F, which prevents the piſton from going too far, when the lever is raiſed as high as it can go in the upright C; and a wire is fixed to the piſton at G, which, paſſing through a ſtaple H, terminates in a bracket I; it ſerves to bring back the piſton to its place, and to keep it in a proper poſition. To this piſton is adapted a tube of tin K, two inches in diameter, and eighteen inches high; this tube is placed exactly under the piſton, and is pierced full of ſmall holes, which are made perfectly ſmooth, ſo as to have no bur on either ſide of them. The top of the tube terminates in a ſort of funnel, alſo made of tin; and at the bottom is fixed a large plate L, from fifteen to eighteen inches in diameter. The tube is ſecured at the bottom by means of a plug of wood, of the ſame diameter as the tube, and which is fixed into the plank. The machine, being thus prepared, is to be uſed in the following manner.

Manner

Manner of uſing the Machine for granulating Potatoes.

Put into a common pot, or boiler of any kind, a very open wicker hurdle, which muſt fit the pot, and be ſupported about two inches from the bottom of it. Pour in as much water as will nearly reach the hurdle, and put the pot upon the fire; fill it up with potatoes, and cover the whole with a linen cloth, wetted and doubled. The water will ſoon be converted into ſteam, which will ſpread itſelf about the potatoes, and will moiſten them, in ſuch a manner that, (without penetrating them too much, or taking their flavour from them, and, above all, *without deſtroying their mucilaginous part,*) they may be eaſily ſtripped of their ſkin, and will be very brittle: when ſkinned let them cool.

Then take the potatoes, thus cleaned and prepared, fill the tube K with them, and, with one ſtroke of the lever DD, you may force all the fleſhy ſubſtance or pulp of the potatoes to go out

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by the ſmall holes made in the tube. This pulp, as it comes out, will take the form of long filaments, ſimilar to vermicelli, which will fall upon the plate, and will there, by their own weight, ſeparate into ſmall pieces, of the ſize of grains of rice.

This kind of vermicelli you muſt throw, as lightly as poſſible, off the plate, into a ſort of baſin made of tin, and pierced full of rather large holes, ſomething like a colander; you muſt then ſhake the baſin backwards and forwards, in the manner in which a ſieve is uſed, over linen cloths covered with unſized paper. When the matter has paſſed through the baſin, you muſt expoſe it to the ſun, or to the heat of a room warmed by a ſtove. There you muſt, from time to time, ſtir this kind of broken paſte with a ſmall rake, made of box wood, and in leſs than twelve hours you will obtain, by this gradual evaporation of the moiſture, a grain ſimilar to rice, of an agreeable ſmell, and tranſparent appearance; which you may put into bags, and ſtow away, without any danger of its growing damp, or of its being deſtroyed by inſects, provided it is placed in a room ſufficiently

ſufficiently expoſed to the air; in that caſe, it may be preſerved ten years, if neceſſary, and poſſeſſes the following advantages.

Firſt. This kind of rice, thus prepared, may, with a ſlight boiling, be uſed in broth, or milk; or be dreſſed with a little butter, &c. like common rice. It is excellent in ſoups, or made into paſte, its original taſte being much improved; in ſhort, it forms one of the moſt agreeable and moſt wholeſome articles of nouriſhment that can be uſed in our ordinary houſehold œconomy.

Secondly. This rice may be ground to a coarſe powder, in a common coffee-mill, and may be uſed in that ſtate for thickening broth, milk, &c.

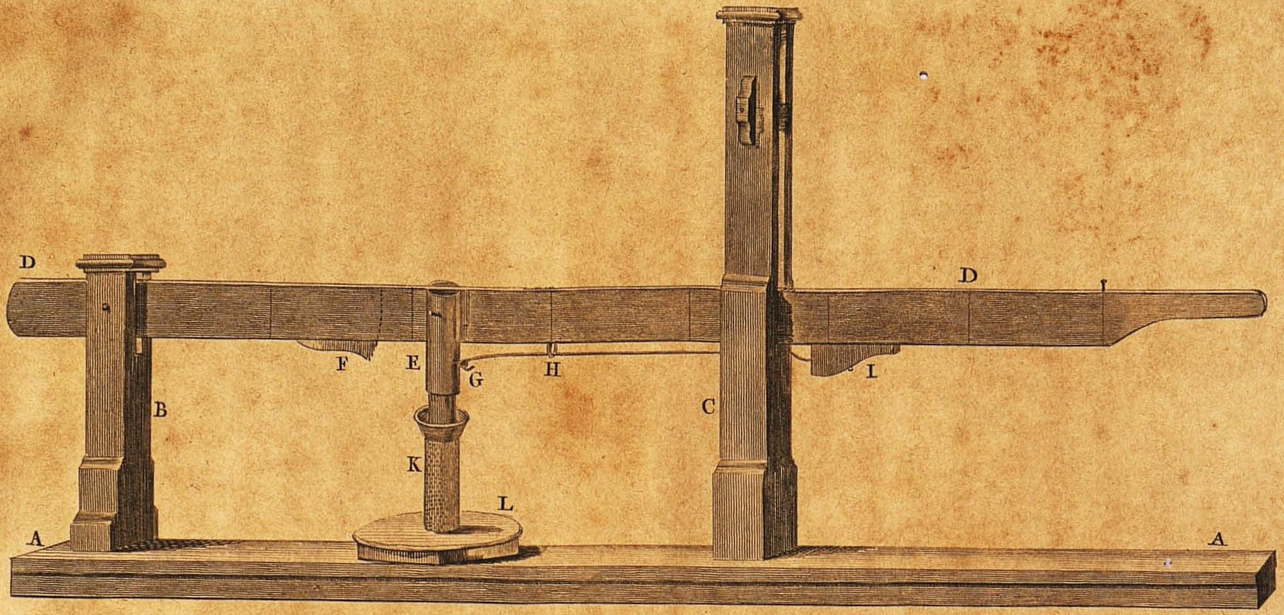
Thirdly. This rice may be ſent to the millers, like common wheat, and be converted into flour; which, by being mixed with common wheat flour, in the under mentioned proportions, makes excellent bread, being very light, and capable of being kept a long time.

Take ten pounds of wheat-flour, and ten pounds of potatoe-flour, prepared in the manner already deſcribed, and from that quantity you may make thirty-five pounds of good bread, which is very

light,

light, and which may be kept freſh for more than a fortnight.

This valuable manner of uſing potatoes has been lately communicated to us by a correſpondent, M. Pictet, Profeſſor at Geneva; where he tried the experiment ſeveral times, and always with the ſame ſucceſs. We intend to make trial of his method here, upon a large quantity, with the concurrence of the commiſſaries of the department, and aſſiſted by the principal bakers of Paris. If our experiments, made in the moſt careful and public manner, ſhould confirm the utility of this proceſs, it will then be proved that France poſſeſſes, within its own territories, a ſpecies of riches to which no other can be compared. From this moment, if we ſhould reſerve thoſe lands which may be left unoccupied, for the purpoſes of paſture and artificial meadows, we ſhall have cattle and manure in ſuch abundance as to be no longer obliged to depend upon our enemies for an article of the firſt neceſſity, of which, at preſent, we are in the greateſt want, and on account of which want we are expoſed to the moſt dangerous diſturbances.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REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXIV.

XLIII. *Specification of the Patent granted to Mr.* Jonathan Hornblower, *of Penryn, in the County of Cornwall, Plumber and Brasier; for his Invention of a Machine or Engine for raising Water, or other Liquids, and for other Purposes, by Means of Fire and Steam.*

Dated July 13, 1781.—Term expired.

TO all to whom these presents shall come, &c. Now know ye, that, in compliance with the said proviso, and in pursuance of the said statute,

I the ſaid Jonathan Hornblower do hereby declare, that my ſaid invention is deſcribed in manner and form following; that is to ſay, firſt, I uſe two veſſels in which the ſteam is to act, and which, in other ſteam-engines, are generally called cylinders. Secondly, I employ the ſteam, after it has acted in the firſt veſſel, to operate a ſecond time in the other, by permitting it to expand itſelf, which I do by connecting the veſſels together, and forming proper channels and apertures, whereby the ſteam ſhall occaſionally go in and out of the ſaid veſſels. Thirdly, I condenſe the ſteam, by cauſing it to paſs in contact with metalline ſurfaces, while water is applied to the oppoſite ſide. Fourthly, to diſcharge the engine of the water uſed to condenſe the ſteam, I ſuſpend a column of water in a tube or veſſel conſtructed for that purpoſe on the principles of the barometer; the upper end having open communication with the ſteam-veſſels, and the lower end being immerſed into a veſſel of water. Fifthly, to diſcharge the air which enters the ſteam-veſſels with the condenſing water, or otherwiſe, I introduce it into

into a ſeparate veſſel, whence it is protruded by the admiſſion of ſteam. Sixthly, that the condenſed vapour ſhall not remain in the ſteam-veſſel, in which the ſteam is condenſed, I collect it into another veſſel, which has open communication with the ſteam-veſſels, and the water in the mine, reſervoir, or river. Laſtly, in caſes where the atmoſphere is to be employed to act on the piſton, I uſe a piſton ſo conſtructed as to admit ſteam round its periphery, and in contact with the ſides of the ſteam-veſſel, thereby to prevent the external air from paſſing in between the piſton and the ſides of the ſteam-veſſel. In witneſs whereof, &c.

XLIV. *Specification of the Patent granted to Mr.* James Herring Robinson, *of Whitby, in the County of York; for an Improvement in the Process of making Alum, whereby that Article will be produced, without injuring the Quality, much cheaper than by any Mode hitherto practised.*

Dated March 29, 1792.

TO all to whom these presents shall come, &c. Now KNOW YE, that, in compliance with the said proviso, I the said James Herring Robinson do hereby declare, that my invention of an Improvement in the process of manufacturing alum, by a new method of mixing the alkaline salts, is described in the following account: that is to say, the common process of manufacturing alum has, to the best of my knowledge, been conducted in the following manner: the rock, after being dug or cut out of its natural bed, is barrowed upon large stacks of wood, or other fuel, which is kindled

dled when properly laden, and more rock added as required; by ſuch means a large heap of rock is calcined, and goes by the appellation of *mine-heap*, or *burnt-mine*. The rock thus calcined is put into pits, and water, or water already impregnated in a ſmall degree from mine, is poured upon it, until it becomes of ſufficient ſtrength for boiling, and is then called *ſtrong liquor*. The boilers, being ſupplied with this liquor, and the loſs by evaporation made good by a farther ſupply, are continued boiling twenty-four hours, or thereabouts, until it is ſufficiently concentrated. It now becomes neceſſary to mix the alkaline ſalts, or alkaline ſolution, with it, which has invariably been done, to the beſt of my knowledge, in the following way: after the alkaline ſalts are diſſolved in ſo large a quantity of water that the ſpecific gravity of the ſolution, or leys, (as commonly called,) is not more than ,06 heavier than common ſpring-water, or five pennyweights, according to the cuſtomary weights uſed by alum-makers, they are run, together with the prepared liquor in the boilers, into a ciſtern or receptacle, called the *ſettler*; where the liquor or mixture, in

two

two or three hours time, is depurated by ſubſidence and precipitation, and leaves a reſiduum or refuſe at the bottom, called *ſlam*. The mixture is then drawn off from the ſettler into other receptacles, called *coolers*, where it remains four days for cryſtalizing; the liquid part, called *mothers*, is then let off, the cryſtals of alum taken out, waſhed in water, and farther depurated or refined by a proceſs called *roaching*. The liquor in which the cryſtals of alum were waſhed is called *waſhings*; and the liquor remaining in the caſks in which they were roached is called *tun-water*, the caſks being called tuns. Now let us return to the boilers, from which the concentrated liquor was run off. After a manufactory has been eſtabliſhed long enough to have mothers drawn off, or ſcooped out of the coolers, the boilers are filled up with theſe, (immediately after having been emptied of the concentrated liquor,) and the loſs by evaporation continually made good with ſtrong liquor from the pits, until, in about twenty-four hours, they are again run off, together with the alkaline ſolution. Now, in this caſe, where the boilers were filled up with mothers, the concentrated

trated liquor, at the time of running off, is at a much greater weight, or too highly infpiffated, to admit of its forming regular cryftals in that ftate; the leys or alkaline folution have therefore always contained fo large a quantity of water, to reduce this highly-concentrated liquor to a proper ftandard of cryftalizing, (the old practitioners not being acquainted with any other better method for making this reduction,) as that they have never, in general practice, exceeded the fpecific gravity before mentioned, of ,06 heavier than common fpring water. The ufual quantity of water ufed in making the alkaline folution was equal to about one half of the quantity of concentrated liquor in the boilers, at the time of running off or drawing off, as ufually termed, or to one third of the mixture when drawn off into the fettler; and, as this water had to be evaporated again out from the mothers, it caufed an expence of about one third of all the fuel ufed at the boiling-houfe, befides other attendant expences. Now my invention of an improvement in the procefs of manufacturing alum has for its object, and principal end, to abolifh the ufe of fo large a proportion of water as has

has been ufual in making the alkaline folution, in any cafe, and in moft cafes to do wholly without any; and to make the reduction of the highly-concentrated liquor to a ftandard for cryftalizing, by means of either the ftrong liquor, or wafhings, which had to go into the boilers at all events. The means I make ufe of are as follow: firft, when the alkaline falts are clean, pure, and commonly good, I caufe about 200 weight to be put into each boiler, (an hour or two before the liquor is drawn off into the fettler,) taking the precaution to put it in at the back; and, to prevent the otherwife too great effervefcence, and in order to reduce the concentrated liquor to a proper ftandard for cryftalizing, I caufe a proper quantity of the ftrong liquor, in common, or wafhings, occafionally, to run off with it into the fettler; the reft of the procefs remaining as has been ufual or cuftomary. Secondly, when the ftrong liquor is not too rich of alum, or not faturated with it, then I caufe about one half of the quantity of alkaline falts ufed *per diem* to be diffolved in the ftrong liquor, and the other half, or one hundred weight to each boiler, is put into the boiling

liquor,

liquor, as in the firſt caſe; the ſolution of ſalts in ſtrong liquor is uſed to make the reduction, in this caſe, as common ſtrong liquor, or waſhings, was in the firſt; the reſt of the proceſs as uſual or cuſtomary. Thirdly, when none but very inferior ſalts can be procured, ſuch as are foul, and cannot ſafely be put into the boilers for fear of burning them out, or making them run, and ſuch as would not depoſit their heterogeneous matters ſo readily in ſtrong liquor, in ſuch caſe, I cauſe a ſaturated ſolution of them in water to be made, of the ſpecific gravity of ,30 or upwards, and mix this ſolution, when clear, with as much ſtrong liquor, or waſhings, as will be required to reduce the concentrated liquor in the boilers to a proper ſtandard for cryſtalizing; the reſt of the proceſs as uſual. In this laſt caſe, it may require rather more than at the rate of two hundred weight of ſalts to each boiler. To the end that the principle upon which my improvement is grounded may be thoroughly underſtood, and that no perſon may imagine that my claim and right, under theſe letters patent, may be eluded by divers variations which may be made in the foregoing pro-

 ceſs,

ceſs, without producing any notable defect in the quantity or quality of alum, and, that the art of manufacturing alum upon this new plan may be gathered from this ſpecification, and perpetuated to the public, I ſhall add the following obſervations. Inſtead of uſing the common leys, or ſolution of alkaline ſalts in pure water, of the ſpecific gravity of ,06 heavier than common ſpring-water, or of five pennyweights, according to the cuſtomary weights uſed by alum-makers, their ſpecific gravity may be increaſed to any given ſtandard ſhort of ſaturation; but, in ſuch caſe, the quantity of leys will be leſs, and will not alone be ſufficient to reduce the concentrated liquor in the boilers to ſo low a ſtandard as is neceſſary for cryſtalization; therefore you muſt take a quantity of ſtrong liquor, or of waſhings, in addition to your leys, to produce the deſired effect. The alkaline ſalts may be added to the liquor when in the ſettler, or even when in the coolers, and that either in maſs or in ſolution. The ſolution of alkaline ſalts may be made in tun-water, or in waſhings, or in ſlam-water, or even in mothers. The concentrated liquor in the boilers, when

ready

ready for drawing off into the ſettler, may be reduced to a proper ſtandard for cryſtalizing by tun-water, by ſlam-water, or by mothers reduced with water. The reduction of the highly-concentrated liquor to a proper ſtandard for cryſtalization, by any of the aforenamed lighter liquids, may be made by firſt putting any of thoſe liquids into the ſettler, or into the coolers, and running the boiling liquor upon it. A ſmaller proportion of mothers than uſual may be uſed to the boilers, or even none at all, and, in ſuch caſe, there will not be need for a light liquid to make a reduction of the concentrated liquor, as, when alkaline ſalts or ſolution is added, the mixture may be at a proper weight for cryſtalizing. In caſe alkaline ſalts cannot be procured, or ſhould be too dear, ſome ſpecies of neutral ſalts may be uſed, eſpecially ſalited mineral alkali or common ſalt. In witneſs whereof, &c.

XLV. *Specification of the Patent granted to Mr.* EDWARD THOMAS JONES, *of the City of Bristol, Accomptant*; *for his Method or Plan for detecting Errors in Accounts of all Kinds, (called the* English Syſtem of Book-keeping,) *whereby ſuch Accounts will be kept and adjuſted in a much more regular and conciſe Manner than by any other Method hitherto known.*.

Dated Jan. 26, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, I the ſaid Edward Thomas Jones do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, the Engliſh ſyſtem of book-keeping requires three books, called a day-book or journal, an alphabet, and a ledger, which muſt be ruled after the following deſcribed method, *viz.* the day-book to have three columns on each page, for receiving the

the amount of the tranſactions ; one column of which to receive the amount of debits and credits, one column to receive the debits only, and one column to receive the credits only ; or it may be ruled with only two columns on each page, one column to receive the amount of the debits, and one column to receive the amount of the credits. There muſt alſo be, on each page of the day-book, four other columns ruled, two on the left ſide, next the amount of the debits, and two on the right ſide, next the amount of the credits, for receiving the letter or mark of poſting, and the page of the ledger to which each amount is to be poſted. The alphabet need not be ruled at all, but muſt contain the name of every account in the ledger, the letter that is annexed to it as a mark of poſting, and the page of the ledger. The ledger muſt be ruled with three, four, five, or ſeven, columns on each page, as may be moſt agreeable, for receiving the amounts of the different tranſactions entered in the day-book ; and the proceſs for uſing theſe books, or making up books of accounts on this plan, is as follows. When a perſon enters into trade, whether by himſelf,

himſelf, or with copartners, he muſt have an account opened with himſelf in the ledger; entering firſt in the day-book, and then to the credit of his account in the ledger, the amount of the property he advances into trade: the account may be headed either with his name only, or elſe called his ſtock account. If you buy goods, give the perſon credit of whom you purchaſe: when you ſell the goods, debit the perſon to whom ſaid goods are ſold. If you pay money, debit the perſon to whom paid, not only for what you pay, but alſo for any diſcount or abatement he may allow, and give the caſhier credit for the neat amount paid. If you receive money, credit the perſon of whom your receive it, not only for what he pays, but alſo for any diſcount or abatement you may allow, and debit the caſhier for the neat amount received; taking care in theſe entries to have nothing myſterious or obſcure, but merely a plain narrative of the fact, introducing not one ſingle uſeleſs word, and avoiding every technical term or phraſe, except the words debit and credit, which are full and comprehenſive, and the only terms that are applicable to every tranſac-

tion,

tion, and may be affixed to every entry. But, as a hurry of bufinefs will fometimes take place in almoft every counting-houfe, which may caufe the entries to be made to the debit inftead of the credit of an account in the day-book, and to the credit inftead of the debit, I have endeavoured, as much as poffible, to counteract the evil, by having only one column for receiving the amount of every tranfaction, whether debits, or credits, at the inftant of making the entry; and, for the convenience of feparating the debits from the credits, previous to pofting, which is neceffary to prevent confufion and perplexity, I have two other columns on the fame page; that on the left fide into which the amount of every debit muft be carefully entered, and that on the right for the amount of the credits; which columns muft be caft up once a month. The column of debits and credits of itfelf forming one amount; the column for the debits producing a fecond amount; and the column of credits a third amount; which fecond and third amounts, added together, muft exactly agree with the firft amount, or the work is not done right. By this means the man of bu-

finefs

ſineſs may obtain monthly ſuch a ſtatement of his affairs as will ſhew how much he owes for that month, and how much is owing to him; and the debits being added together for any given time, with the value of the ſtock of goods on hand, will, when the amount of the credits is ſubtracted therefrom, ſhew the profits of the trade. I ſhall now proceed to the proceſs of poſting; which begins with opening an account in the ledger with every perſon to whoſe debit or credit there has been an entry made in the day-book; affixing to each account a letter, which is to be uſed as a mark of poſting. The perſon's name, place of abode, and the folio of the ledger, muſt then be entered in the alphabet, with the ſame letter prefixed to each name, as is affixed to the account in the ledger. Next the page of the ledger on which each account is opened, (and which will be ſeen in the alphabet,) muſt be affixed to each amount in the day-book, in the column for that purpoſe. The date and amount of each debit muſt then be poſted in the columns for receiving it in the ledger, on the left or debit ſide of that account to which it relates; entering, as a mark of poſting in the day-book, againſt each amount, the

the ſame letter that is affixed to the account in the ledger, to which ſaid amount may be poſted. Obſerving that the debits of January, February, and March, &c. muſt be poſted into the column for thoſe months in the ledger, and the credits muſt alſo be poſted in like manner, filling up each account in the centre, at the expiration of every month, with the whole amount of the month's tranſactions; thus having, in a ſmall ſpace, the whole ſtatement of each perſon's account for the year; in the columns to the right and left the amount ſeparately of each tranſaction, and in the centre a monthly ſtatement. Having deſcribed the proceſs of this method of book-keeping, I ſhall ſhew how to examine books kept by this method, ſo as to aſcertain, to an abſolute certainty, if the ledger be a true repreſentation of the day-book; *i. e.* not only if each tranſaction be correctly poſted, as to the amount thereof, but alſo if it be rightly entered to the debit or credit of its proper account. This examination differs from the modes that have heretofore been practiſed, as well in expedition as in the certain accuracy which attends the proceſs; it being only

 neceſſary

neceſſary to caſt up the columns through the ledger debits and credits, according to the examples given, and the amount of thoſe columns, if right, muſt agree with the columns in the day-book for the ſame correſponding ſpace of time. Theſe caſtings ſhould take place once a month, and, if the amounts do not agree, the poſting muſt then, but not elſe, be called over; and when the time, whether it be one, two, three, or four, months, that is allotted to each column of the ledger is expired, the amount of each column ſhould be put at the bottom of the firſt page, and carried forward to the bottom of the next, and ſo on to the end of the accounts; taking care that the amount in the day-book, of each month's tranſactions, be brought into one groſs amount for the ſame time. But, although this proceſs muſt prove that the ledger contains the whole contents of the day-book, and neither more nor leſs, yet it is not complete without the mode of aſcertaining if each entry be poſted to its right account, which may be aſcertained by the following method. I have laid down a rule that a letter, which may be uſed alphabetically in any form or ſhape

that is agreeable, ſhall be affixed to each account in the ledger, and the ſame letter prefixed to the names in the alphabet, theſe letters being uſed as marks of poſting, and affixed to each account in the day-book as it is poſted; it is only neceſſary therefore to compare and ſee that the letter affixed to each entry in the day-book is the ſame as is prefixed to the ſame name in the alphabet; a difference here ſhews of courſe an error, or elſe it muſt be right. At the end of the year, or at any other time, when perſons balance their accounts, if there be no objection to the profits of the trade appearing in the books, the ſtock of goods on hand at prime coſt may be entered in the day-book, either the value in one amount, or the particulars ſpecified, as may be moſt expedient, and an account opened for it in the ledger, to the debit of which it muſt be poſted. The caſting up of the ledger muſt then be completed, and when found to agree with the day-book, and the amount placed at the bottom of each column, ſubtract the credits from the debits, and it will ſhew the profit of the trade; unleſs the credits be the greater amount, which will ſhew a loſs.

In taking off the balances of the ledger, one rule must be obſerved, and it cannot be done wrong; as you proceed, firſt ſee the difference between the whole amounts of the credits and debits on each page for the year, with which the difference of the outſtanding balances of the ſeveral accounts on each page muſt exactly agree, or the balances will not be taken right. By this means every page will be proved as you proceed, and the balances of ten thouſand ledgers, on this plan, could not unobſervedly be taken off wrong. In witneſs whereof, &c.

XLVI.

XLVI. *Specification of the Patent granted to Mr.* WILLIAM KER, *of Kerfield, in the County of Tweedale, Scotland; for his Improvement in brewing Ale, Beer, Porter, and other Malt Liquors, whereby a very great ſaving is made in the Conſumption of Hops, and Liquor is produced of a ſuperior Flavour and Quality, leſs ſubject to become acid or putrid, and more fit for Exportation to warm Climates, than any Malt Liquor hitherto made.*

Dated March 4, 1788.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I, the ſaid William Ker, in compliance with the ſaid proviſo, do hereby declare, that the nature and deſign of my ſaid invention, and the manner in which the ſame is to be performed, is deſcribed in manner following; that is to ſay, the ſteam which ariſes from the boiling-copper, or any other veſſel

veſſel employed for the purpoſe, and which ſteam is ſtrongly impregnated with the eſſential oil, in which the flavour of hops conſiſts, inſtead of being allowed to eſcape and evaporate, as is done in the preſent mode of brewing, is preſerved and condenſed. The oil and water together are returned into the worts when boiled, or the oil, after being ſeparated from the water, along with which it had been exhaled, is returned into the worts after they are boiled; and the watery part, which, after the oil is ſeparated, ſtill continues impregnated with the aromatic taſte and bitter of the hop, is returned into the next copper or boiling-veſſel; and ſo on, from one copper or boiling-veſſel into another. By which proceſs a conſiderable part of the hop and flavour, which is loſt in the ordinary mode of brewing, is preſerved: the flavour of the liquor is improved by the preſervation of the finer parts of the aromatic oil; and the ale and beer are better ſecured from any tendency to acidity or putrefaction, and therefore muſt be fitter for home conſumption, and exportation. However, neither the principle

nor

nor the execution of this invention depend on the particular way or means by which the ſteam is condenſed and the eſſential oil is preſerved, which may be effected either in a ſtill, or in any copper, or boiler of any kind, having a winding-pipe ſimilar or the ſame as a worm to a ſtill, or a ſtraight pipe laid in cold water, or carried through any cooling body or medium, and, in ſhort, in any of the various ways in which ſteam evaporated from a boiling-veſſel may be condenſed. In witneſs whereof, &c.

XLVII.

XLVII. *Description of a* Steam-Difh, *for making a Potatoe-pafty, with Beef, Mutton, Veal, &c. In a Letter to the Editors.*

WITH A PLATE.

THE very high price of wheaten flour occafions many perfons to ufe potatoes at their meals, as a fubftitute for bread. They are eaten in various ways, boiled, baked whole, or mafhed to cover a piece of meat, and fent to the oven as a pie. The great inconvenience of this pie is that the potatoes firft abforb, and then part with, the gravy of the meat, in the action of baking; leaving the meat dry and hard, and the potatoes too loofe and fodden to be palatable. Thinking a very fimple contrivance would effectually remedy this inconvenience, a tinman in this town has conftructed an apparatus, (from a plan fimilar to the inclofed,) which I have named a *fteam-difh*, that has fully anfwered

anfwered the moft fanguine expectation. It has had a fair trial in my family, and is fo generally approved of, that but few perfons in this neighbourhood are without one. It is found not only to fave the wheaten flour altogether, by the ufe of potatoes, but alfo faves a confiderable portion of butchers meat, and will fupply a family with an excellent meal, at once nutritive, palatable, and fatisfactory, at lefs than three-pence a head. In my own family, of eight perfons, the expence feldom exceeds two-pence halfpenny a head, ufing the beft beaf, mutton, or veal.

Though your publication does not fall into the hands of that clafs of people for whom the *fteam-difh* was principally contrived, its circulation among others will, doubtlefs, give the contrivance publicity, it being not only expedient in the prefent fcarcity of provifions, but may at all times be ufeful and œconomical; and it is fo very fimple in its conftruction, that no tinman can fail in the execution of it.

Description of the Steam-Dish.

The steam-dish is made of an oval form, of common or block tin; but may be made of China, Staffordshire, or Welsh, ware; or (for the better accommodation of the lower orders of people) of any fire-proof earth, and of any shape, if care be taken to make the steam-valve tolerably air-tight.

A B C (Plate XX. Fig. 1.) is the steam-dish with its pasty; C, representing the top of the steam-pipe, with its leafy ornament X; which is to be placed on the pipe, when the pasty is served up to table, but not when sent to the oven.

D E (Fig. 2.) is the steam-dish empty, made of an oval form, and (for a family of six or eight persons) twelve inches by nine, at the top, and nine inches by seven, at the bottom; four inches and a half deep, on the slant rim, and three inches, in the clear, under the resting-knobs 1 2 3 4; which space is to be occupied by the meat of which the pasty is made.

F G H (Fig. 3.) is the perforated cover, with its ſteam-pipe, made exactly to fit the diſh, when reſting on the knobs 1 2 3 4, Fig. 2.

I K L M (Fig. 4.) is the lower part of the ſteam-pipe, with its valve and ſcrew; (one third leſs than the real ſize;) it is ſoldered upon the perforated cover, as at Z, Fig. 3; leaving a ſufficient hole, in the centre of the cover, for the riſing of the ſteam, and play of the valve L, thrown up by the ſteam whilſt the paſty is baking. M is a nut, ſcrewed on to a piece of wire fixed at the bottom of the valve, to prevent the ſteam from forcing it too high in the ſteam-pipe.

Fig. 5. repreſents the ſteam-pipe, with its leafy ornament; it ſcrews on to Fig. 4, and is ſufficiently hollowed, about the ſcrew-part, (as the dotted lines ſhew,) to ſuffer the valve N to play freely. The loops O O are for the purpoſe of lifting off the perforated cover, to ſerve out the meat, when brought to table.

 Having

Having described this culinary apparatus, I shall now give directions for making this cheap family pie.

Directions for making the Potatoe-pasty.

Take of beef, mutton, veal, or other meat, two pounds; let it be seasoned, as for any other pasty, and place it in the bottom of your steam-dish, with a bit or two of butter, (two ounces is enough for the whole pasty, including what is rubbed into the mashed potatoes,) and a sufficiency of water to draw a good gravy; a few slices of carrot may be added, if the pasty is made of mutton.

Take also of potatoes, (mealy ones are best,) one gallon; let them be pealed and boiled until they will mash perfectly smooth; mash them, and rub into them a little butter. When they are mashed, place the perforated cover over the meat, and put the potatoes smooth and even upon it; shaping them up as represented in Fig 1, and pressing them very closely round the edges of the

difh. The pafty may now be fent to the oven; which, if quick, will bake it in an hour, but, if flack, will require an hour and a half; of that the baker will judge from the colour of the cruft, which will, to appearance, refemble the fineft puff paftry.

When the pafty is removed from the oven, the external air clofes the valve; and the fteam, which can now rife only through the holes in the perforated cover, incorporates with the potatoes.

When ferved up to table for the family meal, flices of the potatoe-cruft may be cut off and ferved round; then, by lifting up the perforated cover, you will find an excellent difh of beef, mutton, &c. fwimming in gravy, which is to be taken out and eaten with the potatoe-cruft; and a more palatable mixture, or cheap difh, cannot be ferved to a family; fuperfeding at once the neceffity of wheaten flour for the pye-cruft, and making the fame quantity of meat, of any kind, go farther in the maintenance and fupport of a family than in any other way.

The

The same dish mry be used for a harrico, ragout, turtle, or curry; and, by making the cover-plate, Fig. 3, without holes, and raising a rim on it, as at H, puddings of various sorts may, at the same time, be baked.

I am, &c.

Lewes, Sussex, March 25, 1796.

PHILANTHROPOS.

XLVIII.

XLVIII. *Conclusion of the Count of Rumford's Method of measuring the Intensities of the Light emitted by luminous Bodies.*

(FROM P. 352.)

BESIDES the experiments above mentioned, I made a great number of others similar to them, and with the same view; but, as their results were all nearly the same, I have not thought it worth while to give a particular account of them. In general they all conspired to shew, that the resistance of the air to light was too inconsiderable to be perceptible; and that the assumed law of the diminution of the intensity of the light may with safety be depended on.

That the transparency of air in its purest state is very great, is evident from the very considerable distances at which objects, and such even as are but faintly illuminated, are visible; and I was by no means surprized that its want of transparency

parency could not be rendered ſenſible, in the ſmall diſtance to which my experiments were neceſſarily confined; but ſtill I think means may be found for rendering its reſiſtance to light apparent, and even of ſubjecting that reſiſtance to ſome tolerably accurate meaſure.

An accurate determination of the relative intenſity of the ſun's or moon's light, when ſeen at different heights above the horizon, or when ſeen from the top and from the bottom of a very high mountain, in very clear weather, would probably lead to a diſcovery of the real amount of the reſiſtance of the air to light.

Of the Loſs of Light in its Paſſage through Plates or Panes of different Kinds of Glaſs.

In theſe experiments I proceeded in the following manner. Having provided two equal Argand's lamps, A and B, well trimmed, and burning with very clear bright flames, they were placed over againſt each other before the *photometer*, each at the diſtance of 100 inches from the field of the inſtrument, and the light of B was brought

brought to be of the ſame intenſity as that of A, or the ſhadows were brought to be of the ſame denſity; which was done by lengthening or ſhortening the wick of the lamp B, as the occaſion required. This done, and the two lamps now burning with preciſely the ſame degree of brilliancy, a pane of fine, clear, tranſparent, well-poliſhed glaſs, ſuch as is commonly made uſe of in the conſtruction of looking-glaſſes, ſix inches ſquare, placed vertically upon a ſtand in a ſmall frame, was interpoſed before the lamp B, at the diſtance of about four feet from it, and at ſuch a poſition that the light emitted by it was obliged to go perpendicularly through the middle of the pane, in order to arrive at the field of the *photometer*. The conſequence of this was, that the light of the lamp B being diminiſhed and weakened in its paſſage through the glaſs, the illuminations of the ſhadows in the field of the *photometer* were no longer equal; the ſhadow correſponding to the lamp A being now leſs enlightened by the light of the lamp B, than the ſhadow correſponding to the lamp B was enlightened by the undiminiſhed light of the lamp A.

To determine preciſely the exact amount of this diminution of the light of the lamp B, (which was the main object of the experiment,) nothing more was neceſſary than to bring this lamp nearer to the field of the *photometer*, till its light, paſſing through the glaſs, ſhould be in equilibrium with the direct light of the lamp A; or, in other words, till the equality of the ſhadows ſhould be reſtored; and this I found actually happened when the lamp B, from 100 inches, was brought to the diſtance of 90,2 inches from the field of the *photometer*.

Now, as it has already been ſhewn that the intenſities of the lights are as the ſquares of their diſtances from the field of the *photometer*, the illuminations being equal at that field, it is evident that the light of the lamp B was diminiſhed, in this experiment, in its paſſage through the pane of glaſs, in the ratio of $\overline{100}^2$ to $\overline{90,2}^2$, or as 1 to ,8136; ſo that no more than ,8136 parts of the light which impinged againſt the glaſs found its way through it, the other ,1864 parts being diſperſed and loſt.

To aſſure myſelf that the lamps ſtill continued to emit the ſame relative quantities of light as at the beginning of the experiment, I now removed the pane of glaſs, and found that the equality of the ſhadows was again reſtored when the lamp B arrived at its former ſtation, 100 inches from the field of the *photometer*.

This experiment I repeated no leſs than ten times, and found the loſs of light in its paſſage through this pane of glaſs, taking a mean of all the experiments, to be ,1973 parts of the whole quantity that impinged againſt it; the variations in the reſults of the various experiments being from ,1720 to ,2108.

In four experiments, with another pane of the ſame kind of glaſs, the loſs of light was ,1836; ,1732; ,2056; and ,1853: mean ,1869.

When the two panes of this glaſs were placed before the lamp B, at the ſame time, but without touching each other, and the light made to paſs through them both, the loſs of light, in four different experiments, was ,3089; ,3259; ,3209; and ,3180: mean ,3184.

 With

With another pane of glaſs of the ſame kind, but a little thinner, the mean loſs of light, in four experiments, was ,1813.

With a very thin, clear, clean pane of white, or colourleſs, window-glaſs, not ground, the loſs of light, in four experiments, was, ,1324; ,1218; ,1213; and ,1297: mean ,1263. When the experiment was made with this ſame pane of glaſs a very little dirty, the loſs of light was more than doubled.

Might not this apparatus be very uſefully employed by the optician, to determine the degree of tranſparency of the glaſs he employs, and direct his choice in the proviſion of that important article in his trade?

In making theſe experiments, a great deal of the trouble may well be ſpared; for, there is no uſe whatever in bringing the two lamps A and B to burn with the ſame degree of brilliancy; all that is neceſſary being to bring the ſhadows to be of the ſame denſity with the glaſs, and without it, noting the diſtance of the lamp B in each caſe; (the lamp A remaining immoveable in its place:) for, the relative quantity of light loſt will ever be accurately

accurately ſhewn by the ratio of the ſquares of thoſe diſtances, whatever be the relative brilliancy with which the two lamps burn. The experiment is more ſtriking, and the conſequences drawn from it rather more obvious, when the lamps are made to burn with equal flames; otherwiſe that equality is of no real advantage.

Of the Loſs of Light in its Reflection from the Surface of a plane Glaſs Mirror.

In theſe experiments the method of proceeding was much the ſame as in thoſe juſt mentioned. The lamps A and B, burning with clear, bright, and ſteady flames, were placed before the field of the *photometer*, and one of them was moved backwards and forwards, till the illuminations of the ſhadows in the field of the inſtrument were found to be preciſely equal. The diſtance of the lamp B being then noted, this lamp was removed, and a mirror being put in its place, but nearer the field of the *photometer*, the lamp was ſo placed that its rays, ſtriking the centre of the mirror, were

were reflected againſt the field of the *photometer*; where, by bringing the lamp nearer to, or removing it farther from, the mirror, the illumination of the field by thoſe reflected rays was now brought to be in equilibrium with the illumination of the ſtandard-lamp; and then the diſtance of the lamp from the centre of the mirror, and the diſtance thence to the centre of the field, were carefully meaſured and noted. Theſe two diſtances, added together, gave the real diſtance through which the rays paſſed in order to arrive at the field of the *photometer*.

Now, as there is always a loſs of light in reflection, it is evident that the reflected rays muſt come to the field of the *photometer* weakened; and that, in order to illuminate this field by theſe reflected rays, as ſtrongly as it was illuminated by the direct rays of the ſame lamp, the lamp muſt be brought nearer to the field. It is likewiſe evident, from what has already been ſaid, that the ratio of the ſquares of thoſe diſtances of the lamp, when its rays paſs on directly, and when they arrive after having been reflected, and are found to illuminate equally the field of the *photometer*, will be

Fig. 1.

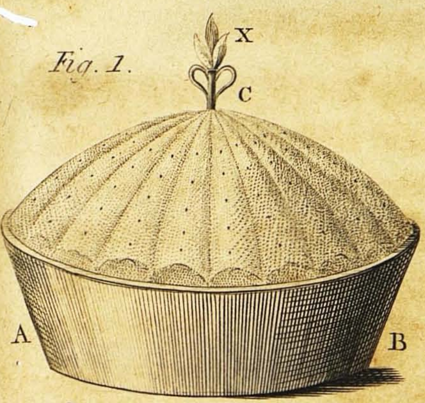


Fig. 2.

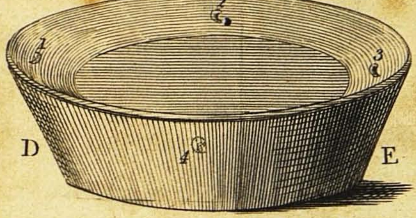


Fig. 3.

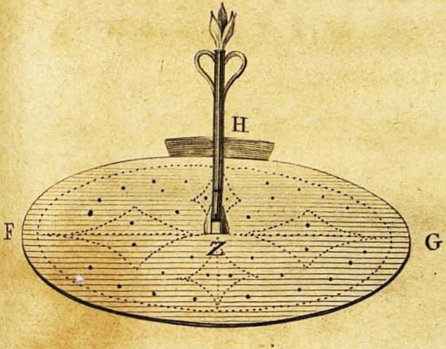


Fig. 4.

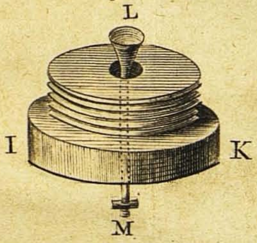
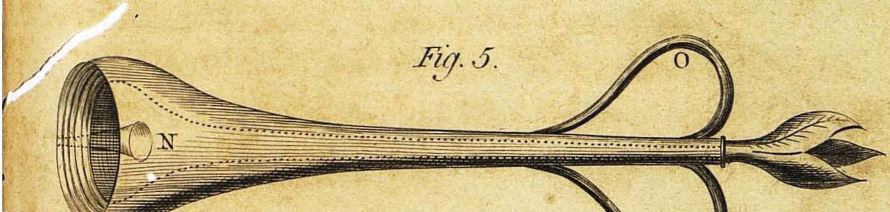


Fig. 5.



be an accurate meaſure of the loſs of the light in reflection.

The following table will ſhew the reſults of five experiments with a ſmall, but moſt excellent, glaſs mirror, made by Ramſden. This mirror, which makes part of an optical inſtrument I cauſed to be conſtructed in London, about twelve years ago, is 7 inches long, and 5½ inches wide, and, I ſuppoſe, is as perfect as ever glaſs mirror was of that ſize.

To facilitate the compariſon of the reſults of the experiments, the lamp B, at the beginning of each experiment, (when the intenſity of its direct rays was compared with the intenſity of the ſtandard-lamp,) was placed at the diſtance of 100 inches, the ſtandard-lamp being occaſionally moved, in order to produce an equality of the ſhadows.

Experiments.	The angle of incidence.	Diſtance of he centre of the mirror from the centre of the field.	Diſtance of the lamp from the centre of the mirror.	Real diſtance of the lamp, or length of the reflected rays.	Light loſt in the reflection.
		Inches.	Inches.	Inches.	Parts.
1	60°	40	40,8	80,8	,3472
2	85°	—	41,	81,	,3439
3	45°	—	41,5	81,5	,3558
4	60°	—	39,5	79,5	,3680
5	70°	—	40,5	80,5	,3520

The mean of theſe five experiments gives for the loſs of light ,3494; and hence it appears, that more than $\frac{1}{3}$ part of the light which falls upon the beſt glaſs mirror that can be conſtructed is loſt in reflection.

The

The loſs with mirrors of indifferent quality is ſtill more conſiderable. With a very bad common looking-glaſs, the loſs in one experiment appeared to be ,4816 parts; and with another looking-glaſs it was ,4548 parts in one experiment, and ,4430 in another. I ſhould certainly have made an experiment to determine the loſs of light in its reflection from the ſurface of a plane metallic mirror, but I had no ſuch mirror at hand.

The difference of the angles of incidence at the ſurface of the mirror, within the limits mentioned, namely from 45° to 85°, did not appear to affect, in any ſenſible degree, the reſults of the experiments. I alſo found, upon trial, that the effect produced by the difference of the angles at which light impinges againſt a ſheet of tranſparent glaſs, through which it paſſes, is, within the limits of 40° or 50° from the perpendicular, but very trifling.

Of the relative Quantities of Oil consumed, and of Light emitted, by an Argand's Lamp, and by a Lamp on the common Construction, with a Ribband Wick.

The brilliancy of the Argand's lamp is not only unrivalled, but the invention is in the highest degree ingenious, and the instrument useful for many purposes; but still, to judge of its real merits as an illuminator, it was necessary to know whether it gives more light than another lamp *in proportion to the oil consumed*. This point I determined in the following manner.

Having placed an Argand's lamp, well trimmed, and burning with its greatest brilliancy, before my *photometer*, and over against it a very excellent common lamp, with a ribband wick about an inch wide, and which burnt with a clear, bright flame, without the least appearance of smoke, I found the intensities of the light emitted by the two lamps to be to each other as 17956 to 9063; the densities of the shadows being equal when,

when, the Argand's being placed at the diſtance of 134 inches, the common lamp was placed at the diſtance of 95,2 inches, from the field of the *photometer*.

Both lamps having been very exactly weighed when they were lighted, they were now (without being removed from their places before the *photometer*) cauſed to burn with the ſame brilliancy juſt 30 minutes; they were then extinguiſhed and weighed again, and were found to have conſumed of oil, the Argand's lamp $\frac{253}{8192}$, and the common lamp $\frac{163}{8192}$, of a Bavarian pound.

Now, as the quantity of light produced by the Argand's lamp, in this experiment, is to the quantity produced by the common lamp as 17956 to 9063, or as 187 to 100, while the quantity of oil conſumed by the former is to that conſumed by the latter only in the ratio of 253 to 163, or as 155 to 100, it is evident that the quantity of light produced by the combuſtion of a given quantity of oil in an Argand's lamp is greater than that produced by burning the ſame quantity in a common lamp, in the ratio of 187 to 155, or as 100 to 85.

The ſaving, therefore, of oil which ariſes from making uſe of an Argand's lamp inſtead of a common lamp, in the production of light, is evident; and it appears, from this experiment, that that ſaving cannot amount to leſs than fifteen *per cent.* How far the advantage of this ſaving may, under certain circumſtances, be counterbalanced by inconveniences that may attend the making uſe of this improved lamp, I will not pretend to determine.

Of the relative Quantities of Light emitted by an Argand's Lamp and by a common Wax-candle.

I have made a conſiderable number of experiments to determine this point; and the general reſult of them is, that a common Argand's lamp, burning with its uſual brightneſs, gives about as much light as nine good wax-candles; but the ſizes and qualities of candles are ſo various, and the light produced by the ſame candle ſo fluctuating, that it is very difficult to aſcertain, with any kind of preciſion, what a common wax-candle

dle is, or how much light it ought to give. I once found that my Argand's lamp, when it was burning with its greateſt brilliancy, gave twelve times as much light as a good wax-candle ¾ of an inch in diameter, but never more.

Of the Fluctuations of the Light emitted by Candles.

To determine to what the ordinary variations in the quantity of light emitted by a common wax-candle might amount, I took ſuch a candle, and, lighting it, placed it before the *photometer*, and over againſt it an Argand's lamp, which was burning with a very ſteady flame; and meaſuring the intenſity of the light emitted by the candle from time to time, during an hour, the candle being occaſionally ſnuffed when it appeared to ſtand in need of it, its light was found to vary from 100 to about 60. The light of a wax-candle of an inferior quality was ſtill more unequal, but even this was but trifling, compared to the inequalities of the light of a tallow-candle.

An

An ordinary tallow-candle, of rather an inferior quality, having been juſt ſnuffed, and burning with its greateſt brilliancy, its light was as 100; in eleven minutes it was but 39; after eight minutes more had elapſed, its light was reduced to 23; and in ten minutes more or twenty-nine minutes after it had been laſt ſnuffed, its light was reduced to 16. Upon being again ſnuffed, it recovered its original brilliancy, 100.

Of the relative Quantities of Bees Wax, Tallow, Olive-Oil, Rape-Oil, and Linſeed-Oil, conſumed in the Production of Light.

In order to aſcertain the relative quantities of bees wax and of olive-oil conſumed, in the production of light, I proceeded in the following manner. Having provided an end of a wax-candle of the beſt quality, ,68 of an inch in diameter, and about four inches in length, and a lamp with five ſmall wicks, which I had found upon trial to give the ſame quantity of light as the candle, I weighed very axactly the candle and

4 the

the lamp filled with oil, and then, placing them at equal diſtances (forty inches) before the field of the *photometer*, I lighted them both at the ſame time; and, after having cauſed them to burn with preciſely the ſame degree of brightneſs *juſt one complete hour*, I extinguiſhed them both, and, weighing them a ſecond time, I found that 100 parts of wax, and 129 parts of oil, had been conſumed.

Hence it appears, that the conſumption of bees wax is to the conſumption of olive-oil, in the production of the ſame given quantity of light, as 100 is to 129.

In this experiment no circumſtance was neglected that could tend to render the reſult of it concluſive; care was taken to ſnuff the candle very often with a pair of ſharp ſciſſors, in order to make it burn conſtantly with the ſame degree of brilliancy; and the light of the lamp was, during the whole time, kept in the moſt exact equilibrium with the light of the candle, which was eaſily done by occaſionally drawing out, a little more or leſs, one or more of its five equal wicks. Theſe wicks, which were placed in

a right

a right line, perpendicular to a line drawn from the middle wick to the middle of the field of the *photometor*, were about $\frac{1}{10}$ of an inch in diameter each, and $\frac{1}{4}$ of an inch from each other; and, when they were lighted, their flames united into one broad, thin, and very clear, white flame, without the least appearance of smoke.

In order to ascertain the relative consumption of olive-oil and rape-oil, in the production of light, two lamps, like that just described, were made use of; and, the experiment being made with all possible care, the consumption of olive-oil appeared to be to that of rape-oil, in the production of the same quantity of light, as 129 is to 125.

The experiment being afterwards repeated with olive-oil and very pure linseed-oil, the consumption of olive-oil appeared to be to that of linseed-oil as 129 to 1[illegible].

The experiment being twice made with olive-oil and with a tallow-candle; once when the candle, by being often snuffed, was made to burn constantly with the greatest possible brilliancy, and once when it was suffered to burn the whole

time

time with a very dim light, owing to the want of ſnuffing; the reſults of theſe experiments were very remarkable.

When the candle burnt with a clear, bright flame, the conſumption of the olive-oil was to the conſumption of the tallow as 129 is to 101; but, when the candle burnt with a dim light, the conſumption of the olive-oil was to the conſumption of the tallow as 129 is to 229. So that it appeared, from this laſt experiment, that the tallow, inſtead of being nearly as productive of light in its combuſtion as bees wax, as it appeared to be when the candle was kept conſtantly well ſnuffed, was now, when the candle was ſuffered to burn with a dim light, by far leſs ſo than oil.

But this is not all; what is ſtill more extraordinary is, that the very ſame candle, burning with a long wick, and a dim light, actually conſumed *more tallow* than when, being properly ſnuffed, it burnt with a clear, bright flame, and gave near *three times as much light.*

To be enabled to judge of the relative quantities of light actually produced by the candle in the two experiments, it will ſuffice to know, that

in order to counterbalance this light at the field of the *photometer*, it required, in the former experiment, the conſumption of 141 parts, but in the latter only the conſumption of 64 parts, of olive-oil. But in the former experiment 110, and in the latter 114, parts of tallow were actually found to be conſumed. Theſe parts were 8192ths of a Bavarian pound.

From the reſults of all the foregoing experiments it appears, that the relative expence of the undermentioned inflammable ſubſtances, in the production of light, is as follows.

		Equal Parts in Weight.
Bees wax.	A good wax-candle, kept well ſnuffed, and burning with a clear, bright flame, -	100
Tallow.	A good tallow-candle, kept well ſnuffed, and burning with a bright flame, -	101
	The ſame tallow-candle, burning very dim for want of ſnuffing, - -	229

Olive-

		Equal Parts in Weight.
Olive-oil.	Burnt in an Argand's lamp,	110
	The ſame burnt in a common lamp, with a clear, bright flame, without ſmoke, -	129
Rape-oil.	Burnt in the ſame manner,	125
Linſeed-oil.	Likewiſe burnt in the ſame manner, - -	120

I ſhould have been very glad to have made the experiment with whale-oil, but there was none to be had in the country I inhabit.

With the foregoing table, and the prices current of the therein mentioned articles, the relative prices of light produced by thoſe different materials may very readily be computed.

The light of a wax-candle, for inſtance, coſts juſt *nine times* more, at Munich, than the ſame quantity of light produced by burning rape-oil in an Argand's lamp.

Of

Of the Tranſparency of Flame.

To aſcertain the tranſparency of flame, or the meaſure of the reſiſtance it oppoſes to the paſſage of foreign or extraneous light through it, I placed before the *photometer*, over againſt the ſtandard-lamp, two burning wax-candles, well trimmed; and, putting them near together, ſometimes by the ſides of each other, and ſometimes in a ſtraight line behind each other, I found that, when their diſtances from the field of the *photometer* were the ſame, the intenſity of the illumination was to all appearance the ſame, whether the light of the one was made to paſs through the flame of the other, or not. And the ſame held good, with very little variation, when three and even when four candles were made uſe of, in the experiment, inſtead of two.

I even cauſed a lamp to be conſtructed with nine round wicks, placed in a horizontal line, and juſt ſo far aſunder as to prevent their flames uniting, and no farther. And I found, upon repeating the experiment with this lamp, that the

the reſult was much the ſame as with the candles; the intenſity of the illumination at the field of the *photometer* being very nearly the ſame, whether theſe nine lights were placed ſo as to cover, and paſs through, each other, or not.

But I afterwards found means to demonſtrate the very great tranſparency of flame by a ſtill more ſimple experiment. Suſpecting that the only reaſon why bodies are not viſible through a ſheet of vivid flame is, that the light of the flame affects the eye in ſuch a manner as to render it inſenſible to the weaker light emitted by, or reflected from, the objects placed behind it, I conceived that a very ſtrong light would not only be viſible through a weak flame, but alſo (as all tranſparent bodies are inviſible) that it might perhaps cauſe the flame totally to diſappear; to determine that fact, I took a lighted candle at mid-day, the ſun ſhining moderately bright, and, holding it up between my eye and the ſun, I found the flame of the candle to diſappear entirely. It was not even neceſſary, in order to cauſe the flame to become inviſible, to bring it to be directly between the eye and the body of the

the ſun; it was ſufficient, for that purpoſe, to bring it into the neighbourhood of the ſun, where the light was very ſtrong; even in a ſituation in which the light was not ſo ſtrong as to dazzle the eye ſo much as to prevent its ſeeing, very diſtinctly, the body of the candle and the wick, not the leaſt appearance of flame was diſcernible, though the candle actually burnt the whole time very vigorouſly.

Explanation of the Figures.

Plate XXI. Fig. 1, Plan of the inſide of the box, and the adjoining parts of the *photometer*.

——— Fig. 2, Plan of the two tables belonging to the *photometer*.

Plate XXII. The box of the *photometer* on its ſtand.

Plate XXIII. Elevation of the *photometer*, with one of the tables and carriages.

XLIX.

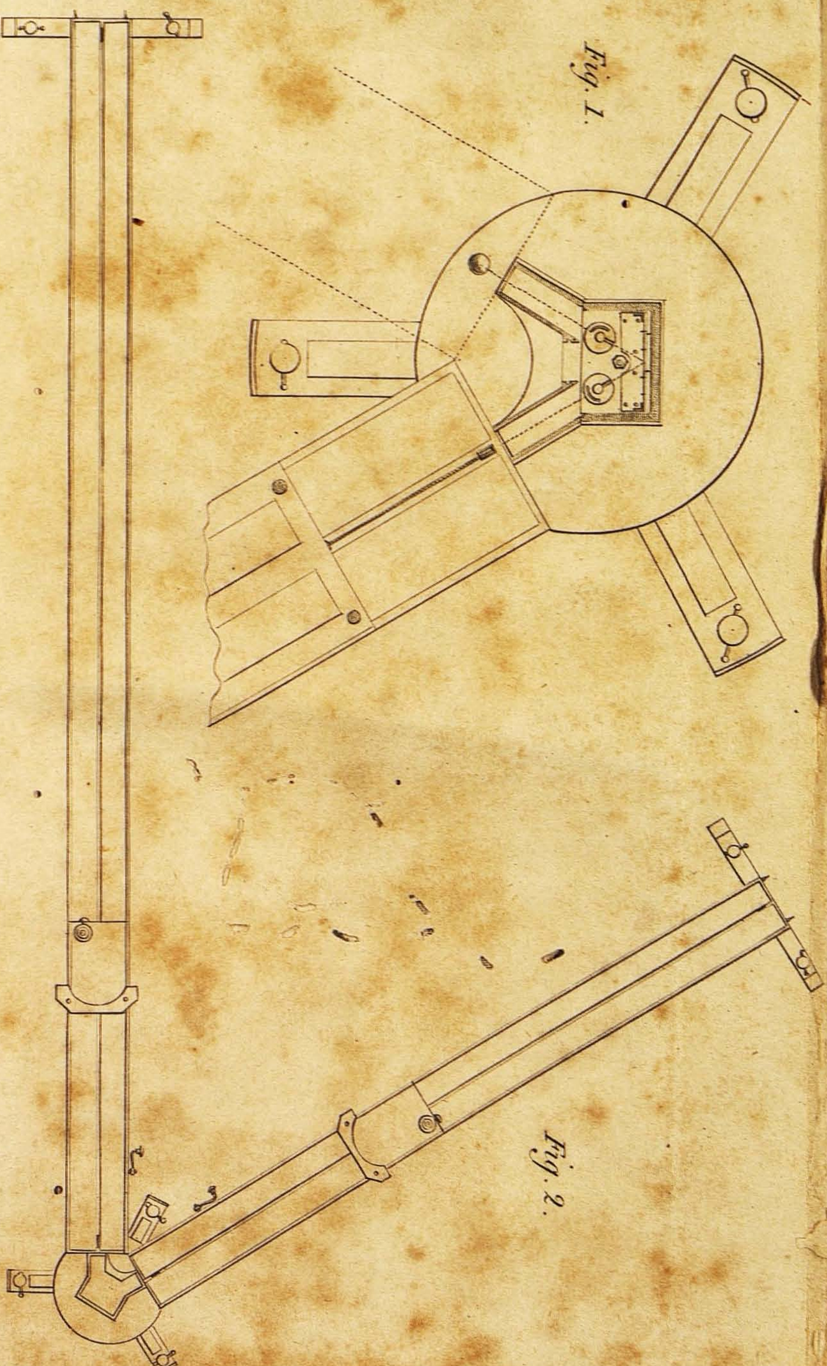
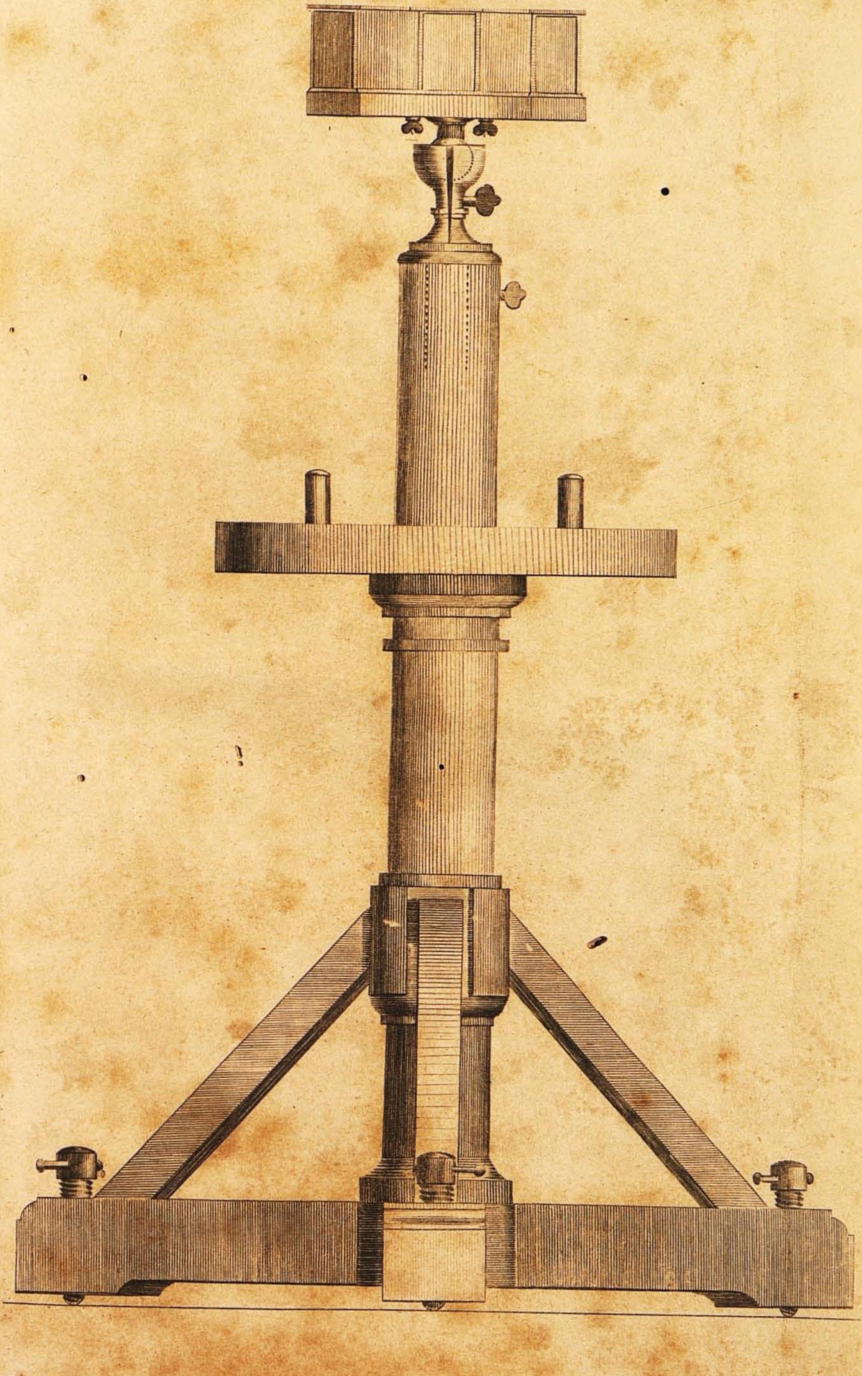
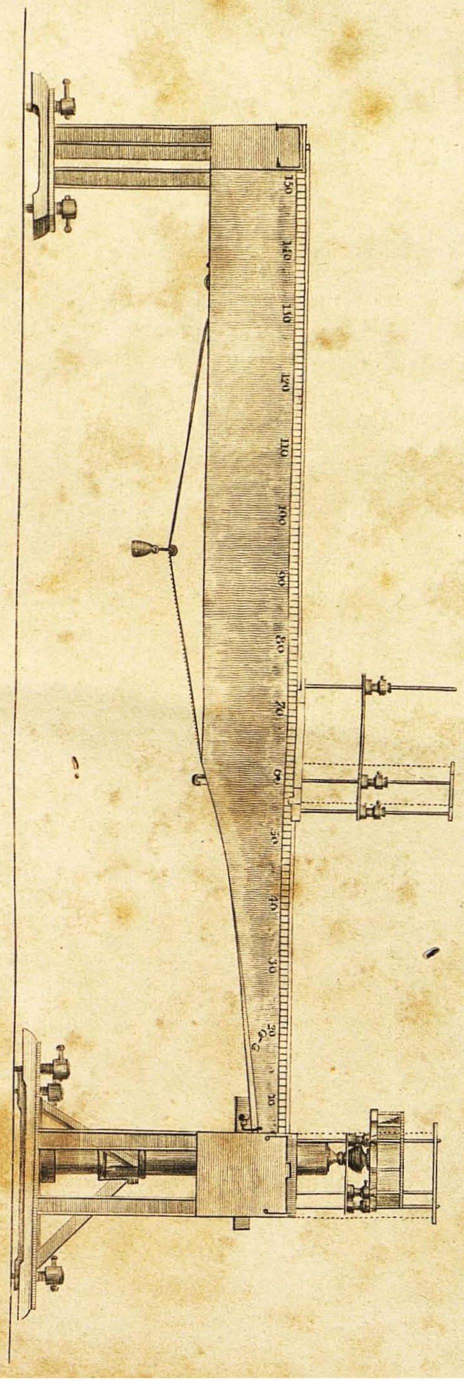


Fig. 1.

Fig. 2.





XLIX. *Deſcription of the Method of preparing Oil-colour Cakes; invented by Mr.* GEORGE BLACKMAN, *of Hemming's Row, London.*

FROM the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The greater Silver Pallet and twenty Guineas were voted to Mr. BLACKMAN, for diſcovering to the Society, for the Uſe of the Public, his Method of making the above mentioned Cakes.

TAKE of the cleareſt gum maſtick, reduced to fine powder, four ounces; of ſpirit of turpentine, one pint; mix them together in a bottle, ſtirring them frequently till the maſtick is diſſolved: if it is wanted in haſte, ſome heat may be applied, but the ſolution is beſt when made cold. Let the colours to be made uſe of be the beſt that

can be procured, taking care that, by washing, &c. they are brought to the greatest degree of fineness possible. When the colours are dry, grind them on a hard close stone, (porphyry is the best,) in spirit of turpentine, adding a small quantity of the mastick varnish. Let the colours so ground become again dry; then prepare the composition for forming them into cakes, in the following manner. Procure some of the purest and whitest spermaceti you can obtain; melt it over a gentle fire, in a clean earthen vessel; when fluid, add to it one third of its weight of pure poppy-oil, and stir the whole well together; these things being in readiness, place the stone, on which your colours were ground, on a frame or support, and, by means of a charcoal-fire under it, make the stone warm; next grind your colour fine with a muller; then, adding a sufficient quantity of the mixture of poppy-oil and spermaceti, work the whole together, with a muller, to a proper consistence; take then a piece, of a fit size for the cake you intend to make, roll it into a ball, put it into a mould, press it, and it will be complete.

When

When theſe cakes are to be uſed, they muſt be rubbed down in poppy or other oil, or in a mixture of ſpirit of turpentine and oil, as may beſt ſuit the convenience or intention of the artiſt.

N. B. It may be proper to obſerve, that Mr. Blackman's colours in bladders are prepared with a mixture of ſpermaceti, and differ from his cakes only in having a larger proportion of oil.

At the end of the foregoing deſcription are teſtimonies from Mr. Coſway, Mr. Stothard, and Mr. Abbot; ſtating that Mr. Blackman's oil-colour cakes work as well as other oil-colours; that their drying without a ſkin upon the ſurface is a great advantage; and that Mr. Blackman's invention is, upon the whole, an eſſential improvement in oil-painting.

L. *Obſervations on an Exploſion cauſed by throwing into Water a Subſtance known by the Name of* Salt of Glaſs *, *while that Subſtance is in Fuſion; by M.* Fougeroux de Bondaroy.

From the Memoirs of the Academy of Sciences at Paris.

THE labours of chemiſts have very much extended our knowledge of the nature and properties of the different kinds of gas; and many members of this academy have employed themſelves in explaining the cauſes of the exploſions occaſioned by theſe gaſes, particularly thoſe of metallic calces precipitated by volatile alkali. I thought, therefore, that I ſhould give pleaſure to many of my brethren, by laying before them a circumſtance of the nature above mentioned, they being more capable than others of determining, in a ſatisfactory manner, whether the exploſion I am about to

* This ſubſtance appears to be analogous to what is here called *ſandiver* or *glaſs-gall.*

deſcribe

describe owes its existence to some species of gas, or whether it is produced merely by the expansion of water, rarefied by a violent degree of heat.

The fact here spoken of has been long known in those glass-houses where soda made from sea-wrack is used as a flux, or, in general, such soda as contains a large portion of sea-salt. I ought to premise, that glass in complete fusion, when thrown into water, does not occasion any explosion: indeed this operation is practised to glass which has been badly made, when it is intended to alter the composition which has rendered it imperfect. The glass loses its transparency by the process, but is afterwards easily beaten into powder; and the workmen are thereby enabled to form a fresh mixture of vitrifiable ingredients, from which there often results a glass of much better quality than the first. This method is practised in all glass-houses, without the smallest appearance of explosion, and without incurring danger of any kind.

But the following circumstance is what occasions the explosion I have mentioned. When the

ashes of sea-wrack, (which contain a great quantity of sea-salt, and which are used in certain glass-houses as a flux,) are mixed with sand, this mixture is exposed to the heat of the furnace, where it is changed into glass; after the fusion is completed, the *salt of glass* separates from the vitrified substance, and rises to the top of the metal, upon the surface of which it swims. Formerly it was the custom to leave this salt exposed to the heat of the furnace a sufficient time for it to be sublimed; and under the salt was found glass free from specks, and in a proper state to be worked, either flat or in cylinders, &c. But since the last forty or fifty years, or thereabouts, it has been found that leaving the salt to evaporate causes an unnecessary waste of fuel, and that it is even advantageous to take it away as soon as it separates itself from the glass, and swims on the top of it. The taking this *salt of glass* from the metal is a very hazardous operation in glass-houses, or other enclosed places, when, in executing it, proper precautions, such as we are now going to describe, are not taken. In all great glass-houses there

are

are ladles of iron, the handles of which are about ſix feet long; the workmen make uſe of theſe to lade out the *ſalt of glaſs* in a liquid ſtate, which the carry away, and pour into a hole or pit, prepared for that purpoſe near the great furnace, that it may be ſufficiently dry and warm.

That every circumſtance of this operation may be underſtood, I muſt here obſerve, that glaſs in fuſion does not adhere to iron, unleſs the iron has acquired a degree of heat which approaches to redneſs; this obliges the workmen to heat their tubes or blowing-pipes, when they want to take metal out of the pot with them, in order to blow or work it. The ladles with which the ſalt of glaſs is taken out become ſo hot, after being twice uſed, that the glaſs adheres to them; it therefore becomes neceſſary to change the ladle as ſoon as the glaſs is found to adhere to it; or, after uſing it twice, to let it cool. That the ladles may be cooled more quickly, it is uſual to throw them into a large trough full of water; but great care muſt be taken that no *ſalt of glaſs* remains in them; ſhould any be left in them when they are thrown

thrown into the water, an explosion, similar to that of a cannon, would take place. The same thing would happen if the ladle, when put again into the pot, contained any water, or even if it were wet; indeed the explosion, in the latter case, would be so violent, that the ladle would probably be driven through the enclosure of the furnace, in such a manner as to expose the surrounding workmen to very great risk. This misfortune is not without example in great glass-houses. The degree of danger attending the explosion is, as must be obvious, in proportion to the closeness of the place in which it happens; it is not equally dangerous in the open air.

At a glass-house situated in Upper Normandy, in the territories of a nobleman whose virtues are his greatest recommendation, (the Duke of Penthievre,) upon occasion of a visit from the said nobleman, it was contrived that a number of workmen should be collected, each of them carrying a certain quantity of the *salt of glass* in a ladle; which they threw, one after the other, at proper intervals, into a vessel of water. By this means a number

number of explosions was produced, which exactly imitated the report of small cannon, or other pieces of artillery.

It must be remembered that this explosion only takes place when the *salt of glass* is produced from soda made of sea-wrack; that which arises from Alicant soda, or from potash, occasions no explosion. I have observed that this latter kind of *salt of glass* contains only vitriolated tartar and magnesia; whereas the former gives sea-salt with an alkaline basis, sea-salt with an earthy basis, and glauber's salt.

Any one who is present at the burning of the sea-wracks which are used for making of soda, may easily convince himself that those species of fucus contain a great quantity of volatile alkali.

May it not be supposed that, during the combustion of these plants, which contain a substance analogous to the corneous matter of animals, there takes place a decomposition of the sea-salt, by means of the volatile alkali, from which an explosion may be produced? If the explosion does not proceed from the expansion of the air contained

tained in the water, it must be the effect of some gas peculiar to sea-salt, and arising, as I have just mentioned, from its decomposition by volatile alkali.

Be that as it may, my intention is only to give an account of the circumstance; and I leave it to my brethren, particularly to M. Berthollet and to M. Fourcroy, to furnish an explanation of it. The assiduity of these able chemists gives us reason to hope that they will make some experiments on the subject, especially as those which M. Berthollet has lately made seem to have some connection with the explosion which I have now described to the Academy.

LI. *On the Power of fixed Alkaline Salts to preserve the Flesh of Animals from Putrefaction; by the Rev.* HUGH HAMILTON, *D. D.*

From the TRANSACTIONS of the ROYAL IRISH ACADEMY.

I CAME to the knowledge of the above mentioned power of alkaline salts, I may say, accidentally: I had a wish to procure some kind of alkaline liquor that might be safely taken, for the purpose of correcting acidities in the stomach. I knew that a solution of salt of tartar was exceedingly offensive to the taste; and that, if it was of strength sufficient to neutralize any quantity of acid in the stomach, it could not be swallowed without danger to the passages, from its causticity. It occured to me, that its causticity might probably arise from its having a strong affinity to something or other, to get at which it burned or

deſtroyed the texture of the fleſh. If this ſhould be the caſe, it was natural to ſuppoſe, that this ſalt, if intimately mixed with fleſh, would ſaturate itſelf with whatever it was that it had ſuch a ſtrong appetite for; and, being ſo ſaturated, it would act no farther on our fleſh, and might, without danger, be taken inwardly. To try this, I firſt incloſed ſome bits of lean raw mutton in a vial, with a ſtrong ſolution of ſalt of tartar; but, after ſtanding ſeveral days, no ſuch alteration as I expected appeared in the liquor. I was willing to account for this, by ſuppoſing the ſalt had a greater affinity to the water than to any thing in the fleſh; I therefore cut ſome fleſh from the breaſt of a turkey, roaſted the day before, and made it as dry as I could; this I pounded in a mortar, adding, by degrees, ſome dry and finely-powdered ſalt of tartar*, until I thought there was enough, for I had no rule to judge by. The mixture grew moiſt; and, when it was ſufficiently

* This ſalt had been ſent to me rendered cauſtic by quick-lime, though I had not deſired it.

pounded,

pounded, I spread it into a thin cake on an earthen dish, and set it before the fire, where it soon became dry. I found it had then a saponaceous mild taste; for, the taste of the salt was scarcely perceptible. Having macerated this flesh in warm water, and poured off the clear liquor, I found it effervesced with vinegar, which shewed that the salt was not so far neutralized but that it would unite itself with an acid, so that I considered it as a mild alkaline liquor, such as I sought for. However, that I might have an opinion from a person of skill on the subject, I wrote to my late worthy and ingenious friend Dr. M'Bride, and acquainted him with the preparation I had made, and the intention of it. In his answer, he was pleased to say he approved of the idea, and would make some of the liquor I described, and let me know what he thought of it. He afterwards wrote to me, and said he had tried the alkaline liquor, and thought it might prove an useful medicine, particularly as it might be mixed with milk and given to children, who have often acids in their stomachs. He also mentioned a physician, then in

Dublin, to whom he had recommended the liquor, and who had found great benefit from it. I firſt made this liquor in the year 1771; and, in the year 1777, being then at Bath, I met with an account of ſome experiments made by Mr. Bewly, an ingenious chemiſt, which plainly proved that fixed air is an acid, and ſaturates alkaline ſalts; this at once informed me what it was, in the fleſh of an animal, that alkaline ſalts had ſuch a ſtrong affinity to. At the ſame time I got from London one of Dr. Nooth's glaſs machines, for impregnating water with fixed air, and to the water I added ſalt of tartar; after this, I thought no more of my alkaline broth, having got a way of obtaining what I wanted in a much more elegant manner.

The only thing now worth attention in the experiment I have related is, that it diſcovered a power in even cauſtic alkaline ſalts to preſerve fleſh, I may ſay, incorruptible; though it has been generally imagined that ſuch ſalts would conſume it. I have ſome fleſh prepared with theſe ſalts in the year 1772; for, finding ſome

 bits

bits made the year before had continued unaltered, I made some more, and laid it by, to see how long it would keep, and what alterations it would undergo. I made it into a cake, and, when quite dry, I cut it into round bits, about the size of half a crown, and put them into a drawer in my desk: I shewed some of them to Mr. Kirwan the summer before last, when I had the honour of receiving a visit from him at Armagh; and a few months ago I found some pieces in another drawer, where they have lain near two and twenty years, and remain unaltered. When these pieces are broken they hang together by fibres, and look like a piece of plaster taken from a wall; the fibrous or stringy parts of the flesh do not seem to have been corroded or dissolved by the salt.

After I knew that fixed air was an acid, and saturated alkaline salts, I began to form conjectures about the means by which these salts had so intirely prevented putrefaction in the flesh to which they were united. Animal substances afford much volatile alkali, and now they are

known

known to contain alſo a volatile acid gas. While theſe two volatile principles continue united with each other, they may prevent any material change from taking place in the ſubſtance; but, if one of them by any means eſcapes, the other will follow; the acid ſeems to be the moſt volatile, and eſcapes firſt, though we may not be ſenſible of its eſcape, becauſe it has no ſuch ſtrong ſmell as the alkali has. The letting looſe theſe volatile principles ſeems to be the beginning of putrefaction. If this be the caſe, we may ſee the reaſon why fleſh, when growing putrid, is reſtored to ſweetneſs by fixed air; that acid replacing what had eſcaped, and retaining the volatile alkali. It is probably on this account, that the aërial acid is found to be of uſe in ſtopping the progreſs of ſome putrid diſorders; it ſeems to act as a ſort of pickle. If vinegar preſerves fleſh by keeping its volatile alkali united with this acid, which is not volatile, we may expect a fixed alkali will have a like effect in preſerving fleſh, by expelling the weaker volatile alkali, and uniting itſelf to the volatile acid, which will therefore be retained.

This

This I found to be really the case; for, while the flesh and alkali were combining in the mortar, a very strong smell arose, like that of *sal volatile*; and, at one time that I used a brass or metal mortar, I perceived its edges to be tinged with blue, which shewed that the metal had been affected by a volatile alkali.

There seems to be a good reason why fixed alkaline salts should preserve flesh much longer than any fluid acid, such as vinegar, can do; for, when the alkaline salt combines with the flesh it expels what is volatile, the mass grows hard, and it is easily reduced to a state of dryness, in which no sort of fermentation, or any intestine motion, can take place, and therefore there is nothing that can effect a change in this compound substance. Whereas, when an animal or vegetable substance is immersed in vinegar, a very heterogeneous mixture is formed, which, in length of time, will be apt to run into a sort of fermentation, with an intestine motion among the minute particles; this will bring on some change in the texture of the substance, and every fermentation,

mentation, when long continued, ends in putrefaction, which, indeed, is said to be the last stage of fermentation.

Whether the conjectures I have offered on this subject be well or ill founded is of but little consequence; the facts I have mentioned may be relied on.

ERRATUM.

In vol. III. page 347, line 7, for *prevent* read *preserve*.

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